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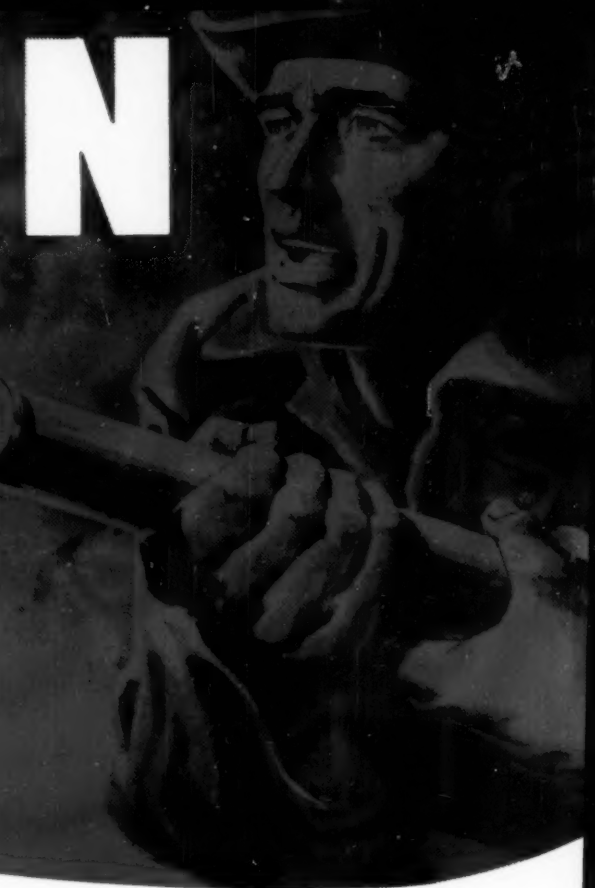

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LEE E. YEAGER, *Forest-Wildlife Management and Recreation*, Colorado Cooperative Wildlife Research Unit, 243 Forestry Building, Colorado State University, Fort Collins, Colo.

LLOYD THORPE, *Advertising Representative*, 212 General Insurance Building, Seattle 5, Wash.

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(Cover courtesy Simpson Logging Co.)

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Journal of Forestry

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The Shelton Cooperative Sustained Yield Unit

David T. Mason
and Karl D. Henze

THE FIRST AND ONLY contract for cooperative sustained yield forest management under the Federal *Sustained Yield Unit Law*—Public Law 273 of the 78th Congress, approved March 29, 1944—between the Forest Service and the Simpson Logging Company became effective on January 1, 1947. This contract, written to operate for 100 years, has now completed its first decade of operation, thus giving an opportunity to consider its working for a substantial period and to judge how the policy set up under Public Law 273 looks in retrospect.

The major ideas underlying Public Law 273 were outlined in the JOURNAL OF FORESTRY of October, 1927.[1] In June, 1931, a report to the United States Timber Conservation Board made more detailed suggestions on the subject.[2] This board in its report to the president recommended legislation along the lines of Public Law 273. The Lumber Code, developed by the lumber industry, negotiated with the National Recovery Administration, and approved by President Roosevelt in 1933, led to important conferences of representatives of the public and industry which recommended such legislation. The so-called "Joint Committee," consisting of representatives of the public and industry, set up in 1934 to promote the recommendations of such conferences, drew up for such legislation a bill which was repeatedly introduced by Senator McNary prior to 1943.

FIG. 1.—Map showing the general location of the Shelton Unit.

Such legislation was discussed by many organizations and groups in many meetings in various parts of the country between 1930 and 1943. No opposition developed, but rather, the discussions resulted in innumerable endorsements of which only the more important are mentioned here. The Act of Congress placing the "O & C Lands" in Oregon under sustained yield management included provision for cooperation between public and private forest landowners.[3]

The "United States Congressional Joint Committee on Forestry," which studied the nation's forest problems, after holding hearings throughout the forest regions of the country, included among the recommmendations in its 1941 report legislation along this line.[4] President Roosevelt in 1942 indicated to the Bureau of the Budget that he would welcome such legislation. The bill which, in amended language, eventually became Public Law 273 was introduced by Senator McNary in January, 1943. The final language of this bill was worked out cooperatively by representatives of the Forest Service, the Bureau of Land Management and the forest industries. The bill itself was approved by the Secretaries of Agriculture and Interior. The bill finally became a law by the signature of the President on March 29, 1944.

The preamble to Public Law 273 states its purposes as follows:[5]

> That in order to promote the stability of forest industries, of employment of communities, and of taxable forest wealth, through continuous supplies of timber in order to provide for a continuous and ample supply of forest products; and in order to secure the benefits in maintenance of water supply, regluation of stream flow, prevention of soil erosion, amelioration of climate, and preservation of wildlife. . . .

The Forest Service and the

THE AUTHORS are consulting foresters, Mason, Bruce & Girard, Portland, Ore.

[1]Mason, David T. Sustained yield and American forest problems. Jour. Forestry 25:625-658. 1927.

[2]Mason, David T. and Donald Bruce. June 4, 1931. Sustained yield forest management. A privately printed report to the Timber Conservation Board.

[3]Public Law 405, of August 28, 1937.

[4]Forest lands in the United States. Senate Document 32—77th Congress. A report of U. S. Congressional Joint Committee on Forestry, 1941 (1938).

[5]Granger, C. M. The cooperative sustained yield act. Jour. Forestry 42:558-559. 1944. (Discusses the Act in some detail.)

Simpson Logging Company intensively studied for many months the feasibility of joining in setting up the Shelton Cooperative Sustained Yield Unit on the Olympic peninsula of Northwestern Washington. A proposed contract was formulated and presented at a public hearing at Shelton in September, 1946. Following this hearing the contract was executed on December 12, 1946, by the Forest Service and the Company.

It is the purpose here to review the principal features of the contract and the way in which they have been carried out. In doing this below the title of each of the more important paragraphs is quoted as it appears in the contract; this is followed by a brief statement of the contents of the paragraph, which in turn is followed by appropriate comments concerning the carrying out of the paragraph, if comment is needed.

Consideration

Mutual benefits from unified sustained yield management of the participating properties.

Duration

From January 1, 1947 to December 31, 2046. This period of 100 years was selected as the suitable rotation for production from seedling to harvest cut for the forest in the unit.

Lands Covered

The attached maps show:

1. The general location of the Shelton Unit in the Olympic area west of Puget Sound, and

2. In greater detail the lands committed by each party to the contract.

The Company lands originally committed were 158,760 acres carrying 973 million feet of merchantable timber; the Forest Service lands were 111,466 acres carrying 4,357 million feet of timber.

Sale and Purchase of Timber

The Forest Service sells to the Company its timber within the unit at prices appraised from time to time according to Forest Service then current standard appraisal procedure. Forest Service sale requirements are to be similar to those applied currently from time to time in comparable Forest Service operations in western Washington. The making of such sales are conditional upon Company compliance with the terms of the contract.

During the first decade the Company cut from Forest Service land 550 million feet of timber for which it paid $9,004,254, or $16.37 per M.

Rate, Methods, and Sequence of Cutting

The average annual cut is limited to the sustained yield capacity of the unit, initially set for the first decade at 100 million feet. The sustained yield capacity and the allowable annual cut is to be redetermined for each decade. Cutting methods are to be designed to assure early, effective reproduction and maximum practicable utilization. Cutting operations are to follow a logical, efficient pattern regardless of ownership. The parties jointly prepare, well ahead of operation, logging plans which are revised annually. Suitable changes of such plans are to be made to meet any catastrophic fire, insect, disease, wind, or other damage. If the parties cannot mutually agree in such planning, the Forest Service determinations shall be accepted and applied.

During the first decade the total actual cut of merchantable timber from the entire unit was 1,006 million feet or very slightly above the allowable cut set to average 100 million feet yearly for the decade. In 1956 the determination of allowable cut for the second decade fixed the figure at 135 million feet average yearly. This increase from the first decade results from several factors including land acquisition by Simpson, better knowledge of the timber resources of the unit, changed utilization standards, and planting and seeding to increase the completeness and promptness of stocking. The harvesting operations are mainly by "staggered settings" on a 3-cycle basis with production volume planned to average 40 percent, 40 percent, and 20 percent for each of the three cycles, respectively.

As an indication of the great advantage of cooperative management of the Forest Service and Company lands within the unit, with an allowable annual cut of 135 million feet, it is pointed out that if there were separate operation of the properties, such allowable cuts with present growing stock would be only 60 million feet and 30 million feet, a total of 90 million feet, for the Forest Service and the Company lands, respectively.

Incompatible Practices

The forest lands in the unit are not to be subjected to farming, grazing, Christmas tree cutting, etc., except as may be approved by the Forest Service.

There were in the first decade no incompatible practices, although there was some cutting of Christmas trees and "greenery," such as ferns cut under suitable regulations.

Fire Protection

Adequate measures for prevention and suppression of fire are required including suitable slash disposal, equipment, detection, closing of operations in dangerous periods, etc. The Company and the Forest Service jointly prepare plans covering all phases of such protection; if there is failure to agree, the decision of the Forest Service shall control.

The fire protection activities of the Forest Service were fully up to its usual standard; those of the Company were unusually intensive, especially in the prevention field, as indicated in the following outline.

1. Normal protection as required by the state, plus membership in Washington State Forest Fire Association—cost 9c per acre yearly.

2. In addition, work financed by Simpson cost during the decade $201,834; it included:

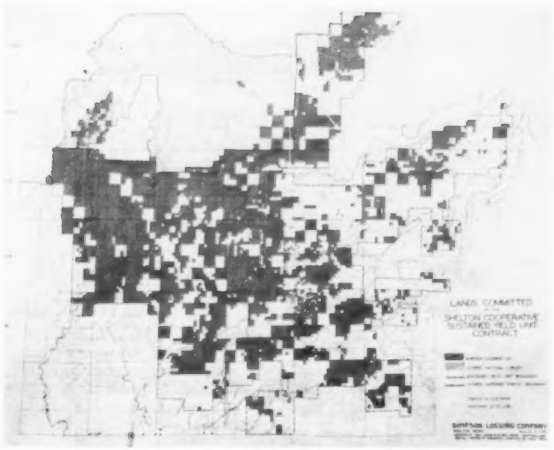

FIG. 2.—Map showing as of January 1, 1958, the lands committed by the United States and by the Simpson Logging Company to the sustained yield unit.

FIG. 3.—Young forest growth on lands of Simpson Logging Company.

a. Snag falling
b. 68 water holes developed
c. 130 miles of protection roads constructed into remote areas
d. Road system maintenance
e. Gates to control public travel
f. One lookout tower to supplement U. S. and State towers
g. Four miles phone line to supplement U. S. and state lines
h. Purchase of fire equipment
i. 10-man suppression crew, April to November, yearly.

3. Simpson's logging and forestry divisions furnished protection personnel when needed. Shut down in low humidity periods. Felling of unmerchantable snags in logging operations cost $600,000 (the part of this cost incurred on National Forest land was appropriately recognized in timber appraisals, as were some other costs such as slash disposal).

4. Joint fire planning meetings.

5. "Keep Washington Green" and other public relation work re fire.

6. Slash disposal.

In ten years one fire in Simpson logging operations covered 70 acres of partially logged area, 30 acres of green timber, the damaged timber was promptly salvaged; 16 fires in immature timber covered a total of 84 acres attributed three to hunters, four incendiary, five locomotive sparks, two lightning, two unknown. In planning and in execution of fire protection there has been the best of cooperation between Simpson and the Forest Service.

Insect and Disease Control

So far as practicable, suitable methods of control shall be cooperatively applied.

During the decade there has been suitable patrol to detect outbreaks of this nature, but no intensive control work has been needed.

Reproduction Surveys and Planting

Steps shall be taken to secure adequate reproduction on lands cut or denuded by fire. Surveys are to be made by each party on its own lands at suitable times within six years after logging or slash burning. If the reproduction is found to be unsatisfactory, steps shall be taken to fill out understocked areas by planting or other effective methods on all sites rated III or better.

On Company land cut after January 1, 1947, about 3,571 acres of reproduction surveys have been made. On this area 2,344 acres were found to be insufficiently stocked; all were planted or seeded before January 1, 1957. Much of such planting and seeding work was done earlier than required by the contract in order to forestall the development of brush.

Similar surveys were made on 46,559 acres of Company land cut prior to January 1, 1947. Of this area 13,409 acres were found to be understocked. Of this latter area 10,773 acres were planted or seeded before January 1, 1957, at a cost of $325,898 using in such work 10,756,400 seedlings and 1,014 pounds of seed. This work on land cut prior to January 1, 1947, was required by the contract. The Company is obligated to extend such surveys and seeding and planting efforts to lands subsequently acquired.

Construction and Maintenance of Road System

The Company shall on its own land construct the more important roads up to Forest Service standards existing at the time. Permanent right-of-way for such roads are to be secured by the Company over non-cooperating lands within the unit. Plans for the road system are to be cooperatively made, but if there is failure to agree, Forest Service decisions shall be followed.

During the decade a total of 309 miles of road was constructed, 191 miles on Forest Service land and 118 miles on Simpson lands, at a total cost of $5,438,000. Maintenance cost during the decade was about $700,000. Although only Company funds were used in such work, Forest Service timber appraisals appropriately recognized the part of such work properly chargeable to the Forest Service.

Utilization Standards

The contract requires that utilization of timber cut from the unit shall be as good as economically feasible at the time.

During the decade utilization has improved and kept pace with improvements in markets and company plant facilities; but at times progress has been interrupted by temporary market recessions.

Manufacturing Facilities—Establishment and Operation

The Company shall have manufacturing facilities suitable for processing at least 80 percent of the volume of the annual cut. Such facilities shall be sufficiently efficient and diverse in character to secure the best use of the logs produced. The Company agrees to develop a well balanced forest products industry at Shelton or McCleary, or within ten miles of these chief centers, and any Company processing plants for utilization of the products of the unit shall not be located elsewhere. The Company plants shall be kept abreast of development in the Douglas-fir region so that they may constantly operate at an efficient level.

At McCleary the Company has a plywood and a sash and door plant, with dry kilns and cut-up plant. During the decade the plywood plant was expanded by 27 percent and the door plant by 37 percent; also equipment was added to make pulp chips from leftovers. At Shelton during the decade the capacity of the two sawmills was expanded by 20 percent, the plywood plant by 52 percent, and the mechanical pulp insulation board plant, first operated in 1947, was increased 20 percent. The Company's employment in the unit areas has been increased by 63 percent to a total of 2,298 persons.

During the decade a whole-log barker was installed at Shelton to secure the highest possible yield of pulp chips for use in the Company's own insulation board plant and in neighboring pulp mills. Research has developed new insulation board products, permitting highest utilization of former waste.

At the beginning of the decade mill leftovers were burned to produce power and steam, and to eliminate excess material. Such leftovers are now so completely utilized that the burner has been dismantled, and in 1956 there were bought 27,352 barrels of fuel oil at a cost of $68,875, and in addition, 103 million kilowatts for $392,464 to operate the plants. During the decade the plants have been developed to high efficiency to utilize the 100 million feet allowable cut; for the second decade, with the new allowable cut of 135 million feet, the plants are receiving further expansion and improvement.

Sales of Minor Forest Products

Either party from its land may dispose of minor forest products as ferns, huckleberry, salal, cascara bark, yew wood, berries, nuts, fuel wood, etc., provided such utilization does not interfere with the main objects of the contract.

The Company has developed and now has under careful supervision about fifty annual permits on about 30,000 acres of its lands for the gathering of ferns, salal, huckleberry, etc., for the floral and decorative trade; these operations employ about 200 full and part time workers. Also the Company yearly through about 15 contracts sells about 175,000 Christmas trees from over-dense young stands; during the season about 50 people are employed in this work.

FIG. 4.—Snag removal is an important part of Simpson's reforestation program.

Sale of Forest Products from Salvage or Thinning Operations

The Company may buy such products from Forest Service land at their appraised value from time to time, but to the extent that such products are not wanted by the Company at the time, the Forest Service may sell to others. The removal of such products shall not be so great as to diminish the ultimate net volume yield of the planned timber harvest. If the Forest Service sells such products to others, the products may be removed over the road system on terms determined by the Forest Service. This class of material is not included in the allowable annual cut.

During the decade available markets did not encourage thinning operations, so practically no work in this field was carried on excepting some company work of an experimental nature. Almost entirely, on Company land, salvage operations have been contracted to small loggers employing annually in recent years an average of 73 people full time and an additional 57 people part time. Such operations have during the decade in a variety of products removed the equivalent of about 60 million feet, log scale.

Major Salvage Operations

If disastrously large volumes of timber require prompt removal because of fire, insects, disease, wind or other damage to timber in the unit, access shall be accorded to other operators if the Company cannot promptly remove the damaged timber. After removal of such damaged timber, there shall be prepared a new cutting budget for the following 10-year period if such losses have substantially affected the allowable annual cut.

No action has been necessary during the decade under this paragraph of the contract.

Local Employment and Harvesting Facilities

For all Company operations lo-

cal labor shall be employed so far as practicable. Operations shall be planned to give as nearly continuous employment as practicable. Any housing facilities maintained by the Company shall be at least as good as those required by the Forest Service at the time on other national forest timber sales in western Washington.

The requirements of this paragraph of the contract are being abundantly carried out. At a cost of more than $600,000 a suitably located central, modern logging community has been established at Grisdale. The Company purchased the entire townsite of McCleary with its manufacturing facilities from their former owners after their timber ran out, thus preserving a community of about one thousand people. With Company encouragement McCleary has become an incorporated community with essentially private home ownership in contrast to its former status as a "company town." With safe assurance in making long-range plans and investments, both the Company and the citizens have greatly improved the Shelton community. Many suitable Company-owned forest areas within the unit have been set aside for use by Boy Scout, Girl Scout, Y.M.C.A., 4-H, and other such organizations and the general public, thus combining recreational use with systematic cropping of forest resources.

FIG. 5.—A railroad bridge constructed by Simpson Logging Company as part of the transportation system of the Shelton unit.

Reservation or Withdrawal of Cooperating Lands

The Forest Service shall be allowed to withdraw from the contract recreational lands along streams or roads or lands needed for power or irrigation reservoirs or for other important public uses. The same shall apply to Forest Service land upon which severe erosion may be expected if the land is logged. The Company may withdraw land for agricultural or other uses giving the soil greater value than for timber growing if such withdrawal is approved by the Forest Service.

The Forest Service has withdrawn from logging 5,910 acres principally at higher elevations where logging might cause excessive erosion. All main streams and lakes on Forest Service land within the area are considered valuable for recreation and are protected in making logging plans, which limit logging to the removal of snags and windfalls.

The Company also on its land leaves timbered strips along main streams and around lakes for recreational use; about 49 miles of road have been constructed through such areas on which no logging, except such salvage occurred. No Company land has been withdrawn for agricultural use.

Commitment of Additional Land

Any land acquired by either party within the unit boundaries shall become a part of the unit, but there is no obligation on either party to acquire land.

The Company has carried on an energetic forest land acquisition program within the unit area to extend the base of this project. During the decade the Company has so added 65,003 acres, thus building up the Company land under the contract to a total of 223-763 acres on January 1, 1957. This has been the principal factor in increasing the allowable annual cut to 135 million feet yearly.

No additional land has been added to the unit by the Forest Service.

Conduct of Cruises, Surveys, or Studies

The parties may independently or jointly conduct such cruises, surveys, or studies as are necessary and basic to the performance of the contract.

The Company's forestry staff has been constantly busy in cruising, surveys, or studies in order effectively to carry out the various activities required by the contract. The Company has constantly sought to improve and modernize its procedures and record keeping in this field; IBM equipment has been installed to aid in this.

The Forest Service by itself, and in cooperation with the Company, has also carried on such work.

Availability of Records

All Company financial and cost records pertaining to its lands within the unit, the logging thereof and the milling and remanufacturing of the products relating to the Shelton Unit shall be available to the Forest Service on a confidential basis.

Such Company records have, of course, been available to the Forest Service as required.

Other Subjects Included in Contract

In addition to the above, the contract includes subjects of a more or less routine nature outside the scope of this discussion on such subjects as Access to Cooperating Lands, Complaint and Appeal Procedure, Transfer of Agreement, Amendments and Termination, Agreement Recordation, Non-participation by United States Delegates and Commissioners, Limitation of Federal Financial Obligations, Separability of Provisions, Execution on December 12, 1946, by President C. H. Kreienbaum of the Company and by Lyle F. Watts, Chief, Forest Service.

Needless to say these provisions of the contract also have been carried out.

In Conclusion

Following the preceding discussion of the nature and carrying out of the contract, some general comments are in order. During the decade the Company invested in plants, railroad, logging equipment, restocking of land, etc., and in additional working capital the total sum of $19,518,946; this is $2,594,939 more than the sum of depreciation and net profit resulting from operations during the period.

It is evident that the Forest Service amply protected the public interest by securing a "tough" contract under which Company has accepted many obligations, especially for the management of its own land, not found in other Forest Service contracts or in contracts between private parties. Usually in private contracts relating to forest land operations there is provision for arbitration of disagreements; but in this contract the Forest Service has the final word in settling many of the most important areas of possible disagreement. During the first decade there have been no serious disagreements; on the contrary there has been admirable cooperation. The Forest Service has carried out its duties under the contract; the Company also has performed its duties and in many respects has gone much further than contract requirements in taking actions beneficial to the success of this cooperative enterprise.

FIG. 6.—Selection of left-over wood from Simpson sawmill provides all the raw material for an insulating board plant employing 300 people in the town of Shelton.

During the first decade of the contract, question has been raised by people not a party to the contract as to whether stumpage returns (revenue) to the United States Treasury, and indirectly to the counties, have been as great as would have been realized in ordinary Forest Service sales. No conclusive answer to this question is possible; but even if competitive sale procedures might have resulted in higher average per thousand feet sale prices, under the cooperative arrangement the allowable cut and the actual cut of timber have been far greater, thus producing much greater total income, and at the same time over a much greater area, converting stagnant virgin stands into young growing timber, which in turn will yield greater total future income.

Under the contract with a substantial continuous supply of timber assured for many years, the Company has been justified in making and has made large capital investments, which have intensified the utilization of the forest and of its products; and this has given more and steady work to more people.

With long life in prospect, the local community has taken on a new and long lease of life, bringing innumerable and in the aggregate large new investments in homes, small business enterprises, civic improvements, etc. There has been increasing employment available. Increased investment by the Company and the general public has increased and stabilized the base for the property tax.

Intensive forest management in the area under the contract has assured "the benefits of forests in maintenance of water supply, regulation of stream flow, prevention of soil erosion, amelioration of climate, and preservation of wildlife." It has brought improved opportunities for recreation. The purposes of the cooperative sustained yield unit law are being achieved.

Aerial Photography As An Aid in Insect Control in Western Pine and Mixed Conifer Forests

Philip G. Langley

THE PROGRESSIVE timber manager has recognized that to obtain maximum financial returns from the forest, he must attain maximum utilization of the timber resources produced. Annual losses from various bark beetles in the western pine and mixed conifer forests run into millions of board feet of high grade sawtimber as well as other lower grade material. This tremendous kill is resulting in serious economic losses to the timber owners and to the country.

Trees killed by insect attacks must be salvaged immediately to prevent severe loss in timber volume. In western pines, blue stain fungi attack the sapwood very soon after death and usually before the tree shows a complete change in color from green to brown. This stain causes lower grade values in one-third to one-half the tree volume. If left for more than a few months the sapwood is invaded by various wood borers and degraded to number four or five common lumber instead of premium select. If left past the first year, the sapwood becomes a complete loss and the heartwood begins to crack and check.

Two major problems must be solved if effective and economically feasible insect control and salvage operations are to be attained. The area must be accessible, and the insect attacks must be detected in their early stages. Many organizations have road systems established and some are salvaging their current timber loss. Many access roads are planned for the future. The early detection problem, however, is in need of technical development.

Various methods have been used in the past to detect insect attacks. Foresters have spent many days driving and walking through the forests searching for the recently attacked trees. In recent years, the airplane has been used more and more for "insect spotting." The advantage of this system is that the ground can be covered much more rapidly for detecting larger outbreaks, groups of trees, and a major portion of the larger individual trees. However, even with a combination of all of these methods, it is difficult to locate all of the trees and windfalls and identify them on the ground for control and salvage purposes. Driving the roads does not give good coverage, searching on foot is much too slow and expensive, and the airplane moves too fast for detailed spotting of the individual trees; windfall detection is nearly impossible except for large groups. The helicopter has recently been employed, but is expensive.

An answer to this problem lies in aerial photography. It combines speed with thorough coverage, a permanent and detailed record of conditions at a given time, and low cost.

To obtain maximum benefit from aerial photographs for insect control work, type of photography, scale, altitude of the camera station, cost, and season of the year must be considered.

To provide a basis for study, a portion of an extensive insect epidemic in second growth ponderosa pine in the vicinity of Lake Tahoe in Nevada was photographed on pan minus blue, infra-red, Ektachrome, and camouflage detection films. The latter is an infra-red sensitive color film. Each film type was exposed at two different altitudes: 5,000 feet and 10,000 feet. Since 1/5000 and 1/10,000 scales respectively were desired, a 12-inch lens was required. Also, an extensive area of lodgepole pine under attack by the lodgepole needle miner (*Recurvaria milleri*) in the Tuolumne Meadows area of Yosemite National Park was photographed on Ektachrome from an altitude of 8,000 feet with the same lens for insect control purposes. Flights were made to photograph virgin and second growth timber from several different altitudes, at different scales, and film and filter combinations in the vicinity of the Blodgett Experimental Forest in California. Several other areas have been photographed on various film-filter combinations, at different altitudes and scales to verify the findings.

Type of Photography

Panchromatic photography showed some usefulness for overall location work but is definitely limited for application to insect detection. Pan minus blue will show the contrast between green and brown trees. However, medium to large scales are required for rapid interpretation, and subtle tone differences are difficult to evaluate. Pan 25A is superior for this purpose as the increased contrast helps in detecting tone differences. However, both of these types have the limitation of not showing clearly the early fading of the foliage that is characteristic of bark beetle attacks. More ground work, therefore, is necessary to check questionable trees with these films than is needed with color films.

Infra-red photography was useful in determining green from brown trees but the subtle tonal differences between crowns were not as apparent here as on panchromatic photography. Infra-red showed the advantage of a marked contrast between brown trees and everything else in the photographs except shadows and water. The brown trees appeared considerably darker than the green trees and most ground features.

Camouflage detection film (color infra-red) shows definite color contrast between healthy, dying, and dead trees. Healthy trees appear bright red, dying trees appear pink to white, while "red tops" appear their natural color. Broad band infra-red reflectance in the commercial pine species of the West appears to have a definite relationship to green and yellow color dif-

THE AUTHOR is chief forester, Airview Specialists Corporation, Pleasant Hill, California.

TABLE 1.—APPROXIMATE COSTS PER ACRE FOR AERIAL PHOTOGRAPHIC COVERAGE

Scale	Black & white & infra-red	Color transparencies or CD	Negative color
		Cents per acre	
1/ 5,000	9.0-9.5	13.0-13.5	15.0-15.5
1/ 8,000	3.5-4.0	5.0-5.5	6.0-6.5
1/10,000	2.5-3.0	3.0-3.5	4.0-4.5
1/15,000	1.0-1.5	1.5-2.0	2.0-2.5

ferences. If trees lost their infra-red reflectance due to the drying process while still remaining green in color, the crowns would show up blue on CD film, since green color normally records as blue. This is apparently not the case in the western pine species. This film does appear to show a slightly greater degree of color contrast between various stages of changing crown color and is definitely superior in distinguishing green foliage from other objects than is any other film and filter combination. It has an advantage in its ability to penetrate haze. This is due mainly to the yellow (G) filter that is normally used with it. This feature makes possible good quality photographs from high altitudes. For good results, however, exposure and processing must be carefully controlled.

Aero Ektachrome color film proved very useful for this type of work. In the bark beetle attacks at Lake Tahoe, the subtle color differences apparent in recently killed trees was readily visible on the photographs and no trouble was encountered in travelling on the ground between individual trees under attack using only single color transparencies for reference. The advantage of this film over CD film is that the features appear in their natural color, making interpretation easier for the untrained person. In the Yosemite area, the lodgepole pine under attack by the needle miner could be distinguished from healthy trees by their thinner crown appearance due to defoliation and brownish color. Those weakened trees that had been further attacked and killed by this insect and the mountain pine beetle could be distinguished by their denuded appearance or completely brown color. The entomologists located on these photographs the areas to be sprayed by helicopters. The pilots used the photos for the ground location of their drops. Here again, proper exposure and processing is very important.

Since this project was completed in 1957, a new negative color film has become available for aerial use. This film has been tested by the author and his associates and its unique properties of printing latitude and color quality indicate exciting possibilities for forest photo interpretation work. Color prints made directly from the negative can be controlled for desired color emphasis and balance, and slight errors in exposure can be corrected. None of these items can be changed with the Ektachrome transparencies.

Scale of Photography

The scale of photography is selected largely by the type of film used, the degree of infestation, the general size of the timber, and the use for which it is intended. In general, the following recommendations can be made:

1. Panchromatic and infra-red films should generally not be used for this type of work except in the cases of heavy infestation which is easily discernible and only a general record of broad information is required. In these cases, 1/10,000 or 1/12,000 scale photos on panchromatic film with a 25A filter may be used. Although considerable information was obtained from these film types, the amount of required field work was greater, the cost was greater, and the general usefulness was not as great as with color films taken at a smaller scale.

2. For control and/or salvage operations, either regular color or CD film is recommended. 1/10,000 or 1/12,000 scale is satisfactory for large timber and 1/5,000 or 1/8,000 scale for small timber except when detailed analysis of individual crowns is desired. In this case, 1/2,500 or 1/5,000 should be used. If cost necessitates a scale of 1/15,000 or smaller, CD film should probably be used, unless exceptionally clear air is encountered, because of its superior haze penetrating ability. The atmospheric haze tends to veil the subtle differences in crown color and obscure detail from high altitudes, making critical examination of tree crowns on small scale photographs difficult. It should also be remembered that small scale photographs are difficult to use for rapid ground checking and orientation without the constant use of a stereoscope. The author feels that any saving in cost effected by the use of small scale photographs would be more than offset by the additional time required for photo interpretation and ground checking.

Cost

The approximate costs for which aerial photographs can be taken are shown in Table 1. They will vary with the specific job and individual contractor.

As an example, the cost of detection and location, after preliminary reconnaissance, of a salvage project on a 25,000 acre tract would be as follows assuming that 1/10,000 photographs taken with negative color film were used:

Cost of photography @ $0.04/acre	$1,000.00
Interpretation (estimated)	375.00
	$1,375.00
Approx. cost of equivalent location work using ground methods with preliminary reconnaissance	$2,500.00

In addition, the time required to prepare ground markers to the trees is about cut in half. The reason for this is that the location of the majority of trees is known in advance. This enables one to start placing his markers at the road and then progress from tree to tree. With the ground method, the trees must first be located in order before any markers are run to them. This is a very time consuming process.

Altitude of the Camera Stations

The altitude of the camera stations above the datum plane is an

important consideration on any aerial photographic project. For planimetric or interpretation work in forest areas, photography from higher altitudes is definitely preferred to low altitude work. This is due to the fact that the parallax difference between the bottom and top of a tree on a stereo model varies inversely as the flying height, provided the base length between photographs remains constant. This relationship is independent of focal length or scale. Thus, the parallax difference between the top and bottom of conifer trees on photographs taken from low altitudes make good stereoscopic fusion difficult, if not impossible. Also, the tree crown images on photos of this type cover up valuable ground detail, making field location work difficult. In general, it is recommended that a minimum altitude of 8,000 above the datum plane be maintained for insect detection work. Once the desired altitude has been determined, within limits, the choice of focal length is dependent on desired scale.

Season of the Year

The season of photography is very important in determining its usefulness for insect damage appraisal. The sun angle should be high, if possible, to reduce shadows to a minimum. This allows better photo interpretation of the ground openings as well as the tree crowns. Also, the backlighted portions of the photographs are held to a minimum. The time of year when new insect damage is most apparent may also be a governing factor. Different fall colors on hardwood leaves could be confusing to the interpreter, while snow on the ground could cause exposure differences within the photograph and tend to cause a veiling effect on the tree images. In conifer-hardwood types, early spring photography before foliation of hardwoods may be desirable. Probably the most important single consideration is the time of year in which the salvage work must be done This is generally in the summer and fall in the western regions.

Method of Use

The general system found desireable for methodical coverage of the ground is as follows:

1. An initial reconnaissance flight should be made to locate the general areas of infestation, the probable extent of the damage, and to permit annotation of these broad areas and groups of trees on a map or existing photographs that show the road system and/or other natural features. The general size of the timber, road conditions, and general economic feasibility of control operations should be appraised at this time.

2. An aerial photographic flight should then be scheduled to cover the immediate and surrounding areas slated for positive action. This photography should be taken on a suitable film-filter combination and scale to do the best job, with due consideration given to justifiable costs.

3. The photographs should then be viewed stereoscopically, annotated, and prepared for field use. This entails detailed study of the area and annotation of the trees and groups of trees suspected to be under attack, and windfalls.

4. Since the aerial photographs provide an overall view of the area, a feasible route to be taken during ground inspection can now be marked on them.

5. A field inspection should be made of all trees and areas shown on the photographs as subject to possible action. At this time the final decision should be made as to which trees are to be logged or treated and the final plans and ground markings made for the salvage and/or control crews to follow. The areas immediately surrounding these tree groups should also be closely inspected for recent activity.

Advantages of the System

This general method of attack has several distinct advantages over the old systems that do not employ current aerial photographs of suitable scale and type.

1. A far more detailed and accurate analysis of a given situation can be made with photographs than can be made from a fast moving airplane. A permanent record that can be used for later reference and comparison is obtained, and the stationary set of conditions portrayed on a photo can be systematically studied.

2. The perspective of the vertical view rather than an oblique view from an aircraft window is superior for crown and ground inspection. Inspection of the ground is important in the pine and mixed conifer regions to detect windfalls that have possible salvage value and which may contain insect broods. Even in moderately dense stands, portions of windfalls lie across openings large enough to indicate their presence.

3. The ground inspection phase of the project is made much more efficient. A good field man can refer to the photos and go from tree to tree as marked on the photographs with only an occasional use of the stereoscope. The color prints now available simplify this step. With good quality color transparencies of a suitable scale, stereoscopic viewing in the field can often be dispensed with. This system eliminates the need of using valuable ground time blindly searching in areas that are free of insect activity. The process of ground searching on large areas without the use of aerial photographs is not only costly, but the limited time available for one season's operations necessitates efficiency. In salvage operations, it is an easy matter to spend too much time on marginal material while high grade trees are missed in other areas.

4. Aerial inspection, rather than ground work, either from a plane or helicopter, or color photographs makes it much easier to scan the tree tops for subtle color and crown density differences which may indicate insect activity.

Conclusion

The problem of controlling losses from various forest insects is becoming increasingly important in the western pine and mixed conifer forests of the United States. The

early detection of these insect attacks is a prime need in gaining control over these losses.

Specialized types of aerial photography are useful and economically practical as a supplement to existing air and ground methods in cases where control measures or salvage operations are to take place. Color photography at suitable scales gives consistently good results if properly used, provide a wealth of detail, and can be very effectively used in saving important time as well as substantially cutting ground costs.

With these developments in mind, it might be well for the forest manager to consider using this additional tool to help enable him to obtain the maximum financial return from his forest land.

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Forestry Section of Northwest Scientific Association Meets

W. F. McCulloch, dean of the School of Forestry at Oregon State College, set the tenor of the thirty-second annual meeting of the Forestry Section of the Northwest Scientific Association. In his welcoming address Dean McCulloch pointed out the past lack of forest research in the Northwest and the sudden awakening of the forestry profession to the need for increased research programs.

At this meeting held December 29-30 at Oregon State College, 40 technical papers were presented in the fields of forest influences, regeneration, silviculture, management and protection. Authors presented all facets of the forestry profession including ten student papers. Dr. J. Richard Dilworth, professor of forest management at Oregon State College, presented a slide talk of European research as the featured speaker at the Section banquet.

The panel discussion on "Trends in Forest Research—Basic and Applied" drew some 100 foresters to hear selected leaders in Northwest forestry. Rudy Kallander, administrator for the Oregon Forest Protection and Conservation Committee, moderated the panel. Panel members included Clifford Bryden, logging superintendent of the Roseburg Lumber Co., who spoke on "What an Operating Company Wants from Research"; Robert Cowlin, director of the Pacific Northwest Station, presented problems and programs of federal agencies in the research field; Dale Bever, acting director of the Forest Lands Research Center, explained the state's program that is supported by timber severance tax funds; John Duffield, technical director of the Industrial Forestry Association research program, developed the various facets of genetics and related studies and their value to the profession and industry; Stanley P. Gessel, professor of forest soils at the University of Washington, spoke on the place of the forest schools in research and the need for training to start early in a forester's career; William H. Cummings, director of Weyerhaeuser Timber Company's research center, made an evaluation of research facilities, personnel and needs as a summary of the panel discussion.

A short business meeting was held to elect next year's section officers. Richard W. Dingle, assistant professor of forestry at Washington State College, was elected chairman and Vernon S. Robinson of Potlatch Forests, Inc., Lewiston, Idaho, was chosen as secretary. The membership voted to have abstracts of the formal papers mimeographed and mailed to the members and other foresters upon request. Requests should be addressed to Louis W. Powell, School of Forestry, Oregon State College, Corvallis, Oregon.

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Diagraming Techniques for Describing Tree Stems and Crowns

R. M. Marden and D. F. Conover

IN STUDIES OF tree quality development, detailed descriptions of individual stem and crown characteristics may be useful. Stem defect indicators can be accurately located and measured and the crown length, width, and relative position recorded to permit future analysis after remeasurement. One way to do this is by diagraming and labeling these features on prepared forms. The following techniques are being used on the Argonne Experimental Forest in northern Wisconsin to test the effects of various cutting intensities and residual stocking levels on quality development of young northern hardwoods.

THE AUTHORS are technologist and research forester respectively, stationed at the Northern Lakes Forest Research Center, Wausau, Wis.

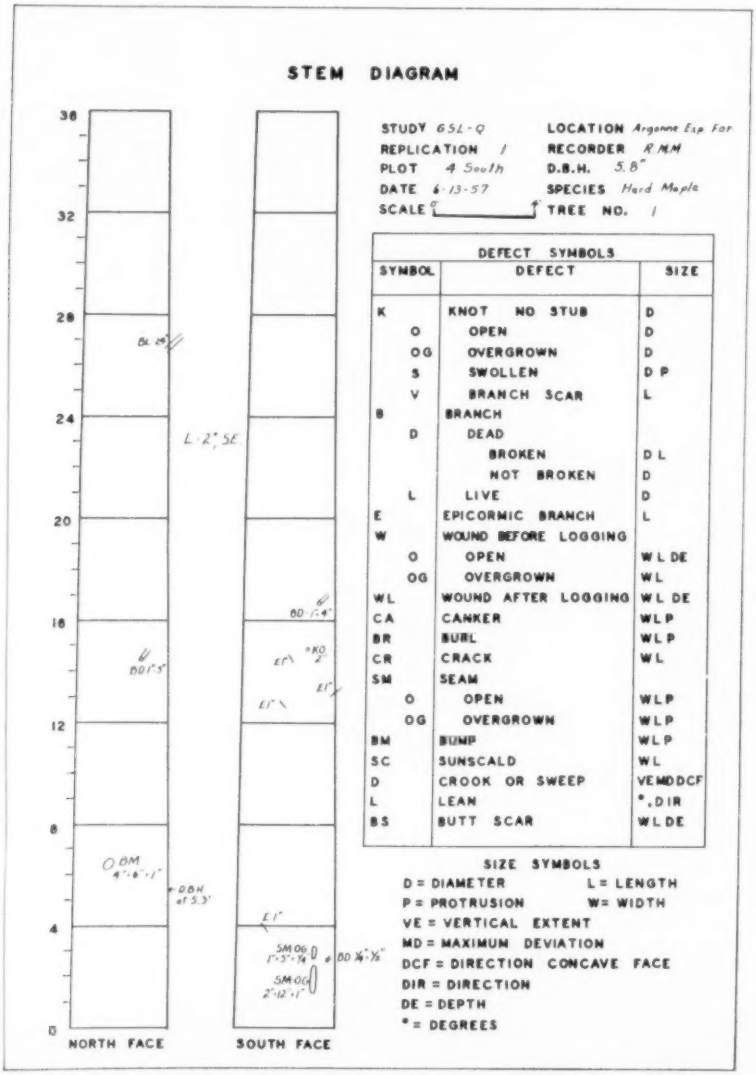

FIG. 1.—Stem diagram. The defects shown in the lower 3-foot section of the south face correspond to the defects in Figure 3. The size symbols in the right-hand column indicate the kind of measurements to be entered on the diagram for each defect.

Stem Diagraming Method

The first step in the procedure is to select sample trees at random from among potential crop trees. The stems of the sample trees are diagramed and photographed prior to cutting the stand to the prescribed stocking levels. The same trees will be diagramed and photographed after each logging operation and at definite intervals throughout the course of the study.

Prior to diagraming, permanent reference marks are established on the stem of the tree to serve as orientation points for all subsequent diagrams. The point of diameter measurement is marked on the stem with a horizontal stripe of paint, and its actual height above the ground is recorded. This is usually at breast height.

To facilitate diagraming, the stem is divided into two equal vertical faces, one face oriented to the south and the other to the north (Fig. 1). The boundaries of the faces are marked at the point of diameter measurement with vertical paint marks about 6 inches long. After the reference points are painted, a 34-foot sectional aluminum pole marked at 1-foot intervals is placed vertically along the east side of the tree to serve as a guide for the location of stem defects. At the time of each remeasurement the pole will be placed at the same height in relation to breast height so that successive diagrams of the same tree will be comparable.

The location, type, and size of each defect indicator are entered on the diagram form as illustrated in Figure 1. The details of the data recorded may be varied to satisfy specific requirements. Lean, crook, and sweep in the standing tree are also measured. A plumb bob device (Fig. 2) supplied by the Forest Products Laboratory, Forest Service, is used to measure the lean of the tree in degrees. The approximate direction of the

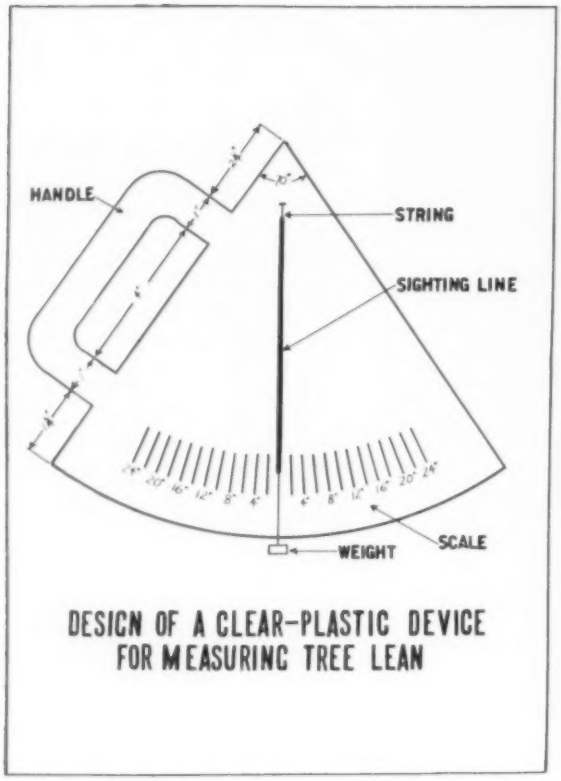

FIG. 2.—Device for measuring tree lean (modified from the Forest Products Laboratory instrument).

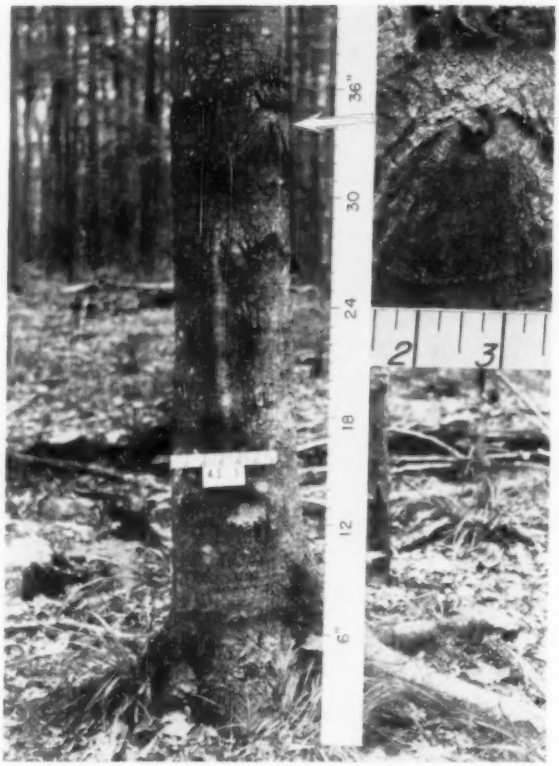

FIG. 3.—Southeast face of the 6-inch d.b.h. sugar maple (*Acer saccharum* Marsh.) diagramed in Figure 1. Inset shows enlarged picture of dead branch indicated by arrow.

lean is determined with a hand compass. The vertical extent, direction of the concave face, and the deviation from straightness are noted for crook and sweep.

The diagrams (Fig. 1) and photographs (Fig. 3) obtained periodically are used for evaluating changes in defect indicators. The location and size of a defect are best illustrated on diagrams while the appearance of the defect is best shown by a photograph.

Relationships between the exterior defect indicators and actual interior defects are determined by dissecting trees outside the plot boundaries. A final evaluation of the effects of the silvicultural treatments on quality will be accomplished by dissecting the sample trees when they reach maturity. Based on the stem diagrams, the sample trees can be stratified into pretreatment quality classes and the volume increment of high-quality wood compared by treatment. These data will be valuable in the formulation of marking guides for the management of young hardwood stands on the basis of stem quality.

Crown Diagraming Method

Tree quality research may also require a study of tree crowns. Crown position, size, shape, and the degree of competition all could affect the rate at which stem defects are grown over with sound wood. In this study, crown diagrams are obtained only for the sample trees and those in direct competition with them to provide a measure of crown changes with time and stand treatment.

The form used for the crown diagram (Fig. 4) was adapted from the 1/10-acre map sheet commonly used for sample plots by the Lake States Forest Experiment Station. "Plot center" is the butt of the sample tree being described. First, the crown circumference of the sample tree is plotted from measurements of crown radii. Sufficient measurements are taken to enable the sketcher to draw in any irregularities in the shape of the crown. Numerous instruments have been designed for the location of the crown edge. An instrument designed by Raspopov[1] was found to be very satisfactory for use after leaf fall (Fig. 5). The device consists of a rectangular box containing a 45-degree mirror and horizontal hair for sighting. It is mounted on a universal joint with a pendulum-like rod for automatic leveling.

The observer walks outwardly from the tree trunk on a crown radius until the edge is sighted in the mirror. The distance and di-

[1]Raspopov, I. M. 1955. K metodike izucenija proekcii Kron devujev. (A method of studying the crown projection of trees.) Bot. Z. 40(6):825-827.

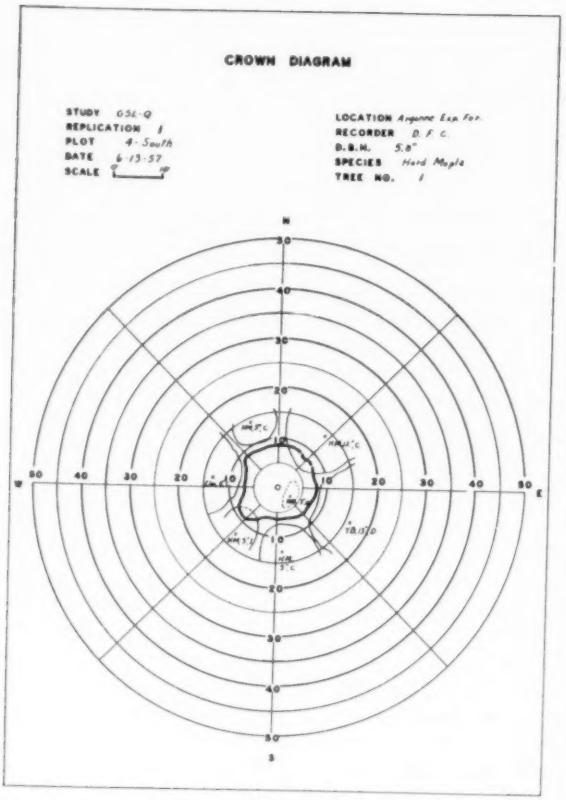

FIG. 4.—Crown diagram. The heavy line indicates the crown of the sample tree, lighter lines indicate surrounding tree crowns, and the dotted lines show the overtopped parts of the crowns.

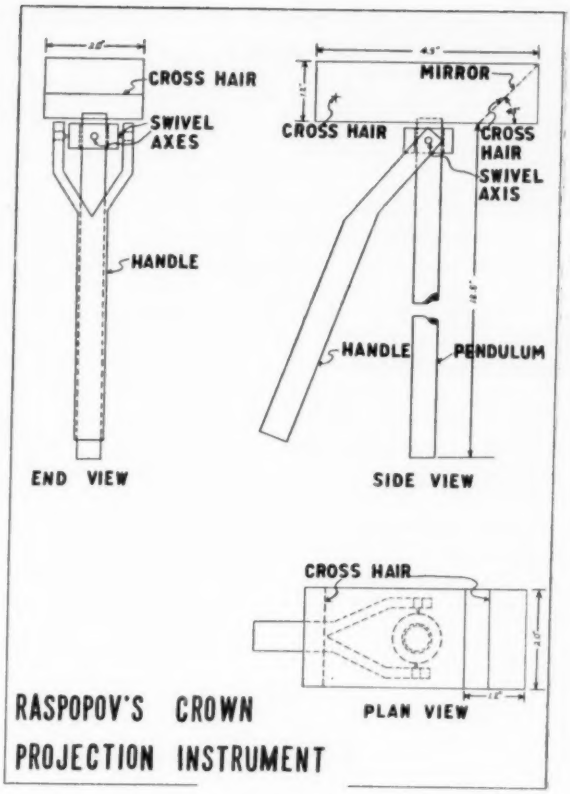

FIG. 5.—Raspopov's instrument for measuring tree crowns.

rection to this point are measured with compass and tape and plotted on the map sheet. Because of the automatic leveling feature and the large size of the sighting box, crown measurements are made rapidly. During the summer when the hardwoods are in full leaf and crown edges are harder to distinguish, a simple stick- and plumb-bob device is more satisfactory.

Next, the trees competing with a sample tree are located and sketched. This is accomplished by locating the butts of surrounding trees and plotting them on the form along with diameter, crown class, and species. Crowns are sketched concurrently showing overtopped parts with a dotted line and non-overtopped parts with a solid line. Trees down to 1 inch d.b.h. are located within the ring of overstory trees. A crown diagram can be made in this manner in about 20 minutes.

These diagrams provide a description of the conditions before logging which would be impossible to obtain with crown classification systems alone. Changes in growth and defect development can be related to the amount of crown area freed from competition on a given side. Finally, existing crown classification systems can be tested and new ones devised if study results indicate the opportunity and need.

Mineral Exploration as a Function of Land Management

Douglas D. Donald

HISTORICALLY, professional land managers have been concerned almost exclusively with forestry and agriculture and all the natural elements which bear on growing conditions, such as soil composition, rainfall and weather, problems of disease control, and similar matters. In concentrating on these factors, they have, for the most part, overlooked the possibility that valuable mineral deposits may underlie the land which is under their supervision. This possibility, referred to as "mineral potential," is one which warrants serious consideration by all who control large tracts of land. Modern exploration techniques permit rapid and inexpensive methods of assessing the mineral potential of large areas. While only a very small percentage of exploration programs discover commercial deposits of minerals, the rewards of a successful program may easily make its cost infinitesimal.

Mineral Exploration Policies

Any organization which controls such extensive land holdings as to warrant professional land management consciously or unconsciously follows one of three basic policies with respect to mineral exploration on its lands. These may be classified as negative, passive, or active policies.

Negative policy.—A land-owning company may refuse to consider mineral investigation either by itself or by another party. Such a policy eliminates the possibility that the company will derive benefit from a commercial mineral deposit which may exist on its land. Of even greater seriousness is the possibility that should it dispose of some of its lands the company might unwittingly be giving away a valuable hidden asset.

Why would any land manager follow such a policy? The principal reason may well be the fear that any mineral discovery would interfere with the normal operations of his company—despite the fact that geological reconnaissance would in no way affect what is growing on the surface. Should initial investigations prove promising, then the advisability of carrying the program further should be determined in the light of surface damage which might result from such work as weighed against benefits that might accrue.

Some land-owning companies today doubtless follow this negative policy, although none can really afford to do so.

Passive policy.—By this term is meant the policy whereby a company is willing to negotiate if approached by outside interests for prospecting rights. This is the most common attitude and at first appears to be the logical approach for land management to follow, but it has certain disadvantages that are not immediately obvious.

Unless the mineral potential of the land is obviously high, a mining company is not likely to be interested in undertaking a mineral survey of it. A passive policy on the part of current ownership can then result in financial loss. A striking case in point is that of a real estate owner who is reported to have controlled at one time more than 100,000 acres in a particular area which was considered to have very little mineral potential aside from extensive sand and gravel deposits. The owner decided to liquidate his holdings. After disposition of all but about 3,000 acres, the state geologists discovered extensive deposits of ilmenite, a primary titanium mineral, a large portion of which are underlying the lands. One of the principal deposits was found on a 12,000 acre game preserve all of which had either been donated or sold to the state at a nominal price. Currently the most promising deposit has been found on a 7,500 acre tract which the owner had sold to a real estate syndicate. This tract is now under option to a major mining company and should the option be exercised, the syndicate is expected to realize a net profit in excess of 400 percent on land owned for less than four years. It is ironic to note that a sizeable portion of this particular tract had once been owned by a company which mines ilmenite elsewhere, produces titanium products less than 100 miles away, and has searched for and examined ilmenite deposits all over the world.

While these deposits were discovered by state geologists on the basis of careful scientific deduction, they would undoubtedly have been revealed in the course of a systematic geological reconnaissance program. Ilmenite values that would warrant detailed investigation may be noted at the surface or just beneath a thin cover of topsoil quite generally over an area of about 200 square miles.

Another disadvantage of relying on an exploration company to carry out a mineral survey is that their efforts are naturally oriented towards the specific minerals of interest to them. In the active search for metallic ores commercial nonmetallic mineral deposits are, all too frequently, neglected.

Without venturing too far afield, it is appropriate to cite the case of exploration drilling which was done in Saskatchewan, Canada, in search of oil. No oil or gas was discovered in commercial quantities in this particular area, but substantial thicknesses of high grade potash were encountered.

THE AUTHOR is connected with the firm of Behre Dolbear & Co., Inc., mining, geological, and metallurgical consultants, New York City.

The oil companies failed to recognize the value of their discovery, but fortunately for the Province, there is a law requiring publication of the results of exploration drilling for oil. This information was available to the public for several years before its significance was recognized. Now nearly every domestic potash producer, as well as a number of foreign ones, have obtained potash holdings and the area is generally regarded as containing the greatest known deposit of potash in the world.

When a landowner succeeds in getting a mining company to carry out a mineral exploration program he should recognize the facts that such a program will probably not be exhaustive and that the exploration company will feel entitled to a greater share of any future profits resulting from their efforts than if the owner had offered specific favorable indication in advance. The owner must decide for himself to what degree he is willing to share the risks as well as the potential reward.

Active policy.—This policy is applied by a company that is willing to initiate and maintain a mineral exploration program on its own behalf. There exists the possibility that each and every acre of ground is underlain by a commercially valuable mineral deposit, or orebody. The probability that any given area is underlain by an orebody may be considered the mineral potential of the area, which can only be assessed by a systematic mineral survey. It is the contention of this paper that it is in the best interest of any individuals or company holding extensive tracts of land to determine the mineral potential of their land. Using modern methods in conjunction with available geologic information, an effective mineral survey can be carried out rapidly and at relatively low cost. The cost of a survey cannot be determined without knowing the size and location of the tracts, the amount of pre-existing information which is available, and the methods of prospecting to be used. Experience indicates, however, that mineral reconnaissance costs run between $.10 and $.75 per acre.

Steps in a Mineral Exploration Program

Geological reconnaissance.—A mineral survey, or geological reconnaissance as commonly called, is the basic step in any program of mineral exploration. Its object is to assess in a very general manner the mineral potential of large areas of land and to indicate what portions, if any, of the total area warrant additional study. If further investigation is warranted, this first step provides background for subsequent work. Aside from reducing the area to be investigated, the reconnaissance will suggest what type of minerals should be sought and what methods should be used.

Basically there is no difference in the objectives of a modern reconnaissance program and those of the prospector of years ago. In execution, however, there is a vast difference in the methods and tools which are currently available to accomplish this work. General geological information is available for all of this country and a great mass of detailed geological data has been compiled by federal and state geological organizations, by educational and scientific institutions, and by private companies. Aside from the work done privately, most of the data have been published or are otherwise available.

Virtually complete aerial photographic coverage of the United States has been carried out by various government agencies. While the quality of some of the earlier work is not up to the high standards of today, it is all very useful in carrying out geological recon-

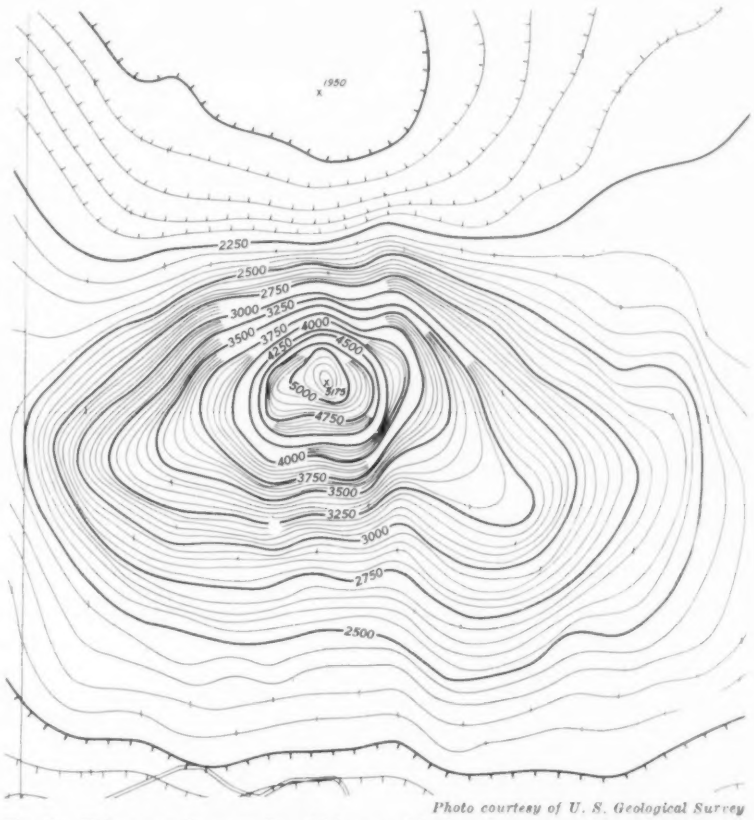

Photo courtesy of U. S. Geological Survey

FIG. 1.—This magnetic anomaly, which was picked up by an aerial geophysical survey, led to the discovery of a major iron ore deposit in Missouri. The orebody is covered by a minimum of 1,500 feet of sediments and there is no surface indication of its presence. It has been estimated that $30,000,000 will be spent to bring this 100,000,000 ton deposit into production.

Points of equal total magnetic intensity are located through use of magnetometer.

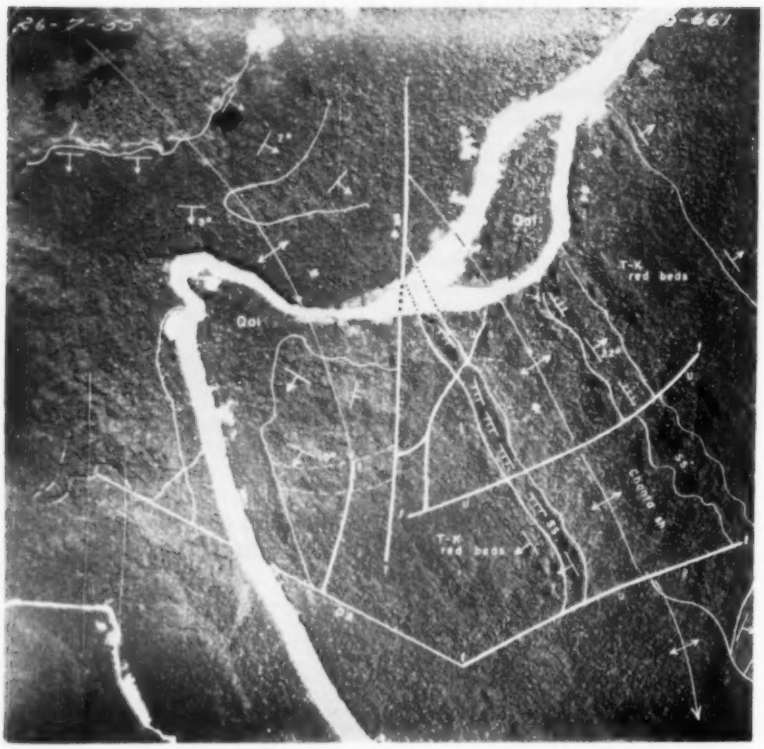

FIG. 2.—An example of photogeologic interpretation of a jungle area in eastern Peru. The attitude of underlying rock formations may be interpreted through analysis, greatly reducing necessary amount of field surveying. *Photogeology by Geophoto Services, Denver.*

naissance. The science of photogrammetry was brought to a high level of development during World War II and since that time great strides have been made in the branch known as photogeology.

The field of airborne geophysics has shown most spectacular development and results in mineral exploration work. Not only have aerial techniques been devised to record deviations in the earth's magnetic field which may be caused by geological features, but also to record variations in electrical conductivity and radioactivity of underlying rocks. The most recent development is a technique by which gravity anomalies may be determined from the air. Continuing geophysical research is resulting in the development of highly refined instruments and methods which permit the recording of anomalies occurring at increasing depths below the surface of the earth. The use of the helicopter in special cases has enabled the airborne geophysicist to obtain certain results not formerly available.

Still another field and one which did not exist 15 years ago is that of geochemical prospecting. Simple field techniques have been devised for testing the heavy metal content in waters that are sensitive to such low concentrations as 5 parts of heavy metal per billion parts of water. Somewhat more complicated procedures have been developed for testing the metal content of soils and soil samples may often be analyzed for less than 50 cents per sample. Geobotany is yet another type of geochemical prospecting, but one which has not found as broad an application as water and soil sampling because it is considerably more costly and is not considered as effective as soil sampling.

By properly utilizing available geological information, coordinating it with field observations, and applying the appropriate techniques it is now possible to carry out geological reconnaissance of large areas with greater thoroughness than ever before and at a relatively low cost per square mile.

Subsequent investigation.—Should geological reconnaissance reveal conditions suggesting the presence of a commercially valuable mineral deposit, then the mineral exploration program should be carried a step further. Detailed investigation should be carried out by whatever methods appear appropriate, depending on the nature of the favorable indications. Mapping of the surface geology, possibly using enlarged aerial photographs or topographic sheets as base maps, is usually the most important phase of this step unless it appears that the underlying rocks are obscured by soil, water, or other geologically uninteresting formations.

The mapping may be carried out in conjunction with surface geophysical surveys or systematic geochemical sampling. The results of this sort of investigation should determine whether or not the mineral potential of the area is great enough to justify carrying the exploration program through the final step, namely testing.

Testing.—At this stage the geologists should know what they are looking for and approximately where it may be found. If the potentially valuable deposit outcrops at the surface the geologists' job is considerably simplified and some of the testing may be carried out by means of surface trenches and shallow pits. More frequently, however, testing will have to be carried out by drilling of one sort or another. The object is to determine whether or not the deposit is truly of commercial size and grade. The amount of drilling required to accomplish this purpose is largely dependent on the nature of the deposit and may vary from one or two dozen holes in the case of a continuous bedded deposit such as coal, potash, or limestone to hundreds of holes in the case of irregular deposits.

Again depending on the nature of the deposit, it may be necessary

to carry out extensive metallurgical tests to determine the recoverability of its commercial contents.

Any mineral exploration program may be divided into three logical steps: reconnaissance, investigation and testing. The results of each step determine whether the subsequent one should be initiated and what methods are applicable. The costs of exploration per square mile increase substantially with each step while the target area is being narrowed down and the probability that a commercial deposit does exist is being increased.

Initiating an Exploration Program

An active mineral exploration program may be carried out by a company that is not primarily in the business of finding or developing mineral resources in either of two ways. One plan, which is more applicable to a small company, is to engage a firm of consulting geologists to carry out the program. The other method, one more appropriate for a company with extensive land holdings, is to establish a small geological staff of its own. Such a staff, under the direction of an independent senior geologist, or preferably a group of geological consultants, in order to draw from more varied experience, could carry out a long range program that would ultimately assess the mineral potential of all lands controlled by the company or under consideration for purchase or sale. An effective program of this nature might be undertaken on an annual budget of as little as $25,000 per year exclusive of the costs of any airborne geophysical surveys undertaken.

As soon as its exploration program has revealed promising indications of an orebody, the company is in a position to decide whether to investigate more thoroughly itself or to negotiate with a mining company. It should be pointed out that the federal government, through the Defense Minerals Exploration Administration, has been willing to provide loans for exploration purposes to companies and individuals able to provide satisfactory indications of the presence of specified mineral commodities. Should commercial deposits result from these indications, these loans are repaid within a period specified in the contract (usually 10 years). Should no commercial deposits be found, the contract will be terminated and the government retains no claim or lien against the property. During the last three months of 1957 the government was lending up to 50 percent of the total exploration costs for such commodities as copper, lead, zinc, uranium, tungsten, and mercury. It would lend up to 75 percent for beryl, strategic mica, nickel, cobalt, manganese, and certain other commodities.

Mr. Donald's article deserves the serious consideration of owners of forest properties. It says in effect to such owners "your lands may have mineral possibilities that you are overlooking. It is feasible for you to survey these possibilities just as you survey the wood production potential of your lands. If your principal management objective is the production of wood, pretty generally you will find that the production of minerals will not be in serious conflict with this objective; and you may discover an important new source of revenue."

It is interesting to note that this concept is the exact opposite of that of the early land companies which put together large land holdings for their potential mineral value, and developed forest operations as a secondary objective. This was true of the major iron and copper companies in Michigan's Upper Peninsula.

The development of mineral resources has long been a part of the multiple-use policy of many federal and state agencies charged with the responsibility of land management. This has been true of the Michigan Department of Conservation for which I worked for many years. Using its own geologists for exploratory purposes in the four million acres of land under its supervision, the Department developed leases with mining companies covering a variety of minerals including sand, gravel, limestone, iron, copper, oil and gas. The state's current revenue from mineral leases approximates ¾ million dollars annually.

Should a private company undertake a preliminary mineral survey, the decision as to which course of action to pursue from there on, will depend, of course, upon the results of the preliminary survey, and upon the ability of the company to finance further surveys of mineral possibilities indicated.

S. G. FONTANNA

Colchicine-Induced Polyploidy in Pines

François Mergen

In 1936, Nilsson-Ehle discovered a triploid aspen in Sweden which grew more rapidly than the diploid aspens, and this finding generated great interest in the potentials of breeding polyploid forest trees. Efforts to induce polyploidy by physical means such as X-ray, heat, or ultrasonic treatment are only moderately promising in trees and require expensive equipment, whereas colchicine (C_{22} H_{25} NO_6) effectively doubles the chromosomes and is not costly. This accounts for the widespread acceptance of colchicine by forest tree breeders.

Since the qualities of colchicine were discovered, a great number of new plant varieties which originated either directly or indirectly from colchicine treatment, have been patented. One of the recent additions to this list is the "Beatrix Farrand Forsythia," a triploid plant whose flowers are about three times the size of diploid forsythia. With forest trees, however, the results have been less spectacular and rather discouraging. One of the difficulties lies in the failure to produce, on a large scale, polyploids which are able to survive and produce fertile flowers.

The purpose of this investigation was to obtain more satisfactory treatment techniques for pines, and various methods were tried and modified in an effort to obtain a large number of polyploid individuals. When polyploidy is induced in young seedlings, a considerable period of time will elapse until they produce fertile pollen or fertile ovules. Many of these polyploids succumb during this interval. Therefore, if chrofosome doubling can be achieved during the development of the male reproductive structures, the diploid pollen can be used directly in controlled pollinations to obtain triploid progeny.

THE AUTHOR is assistant professor of forest genetics, Yale University, School of Forestry, New Haven, Conn.

In this paper are reported the results of a series of studies on the induction of polyploidy in pine, by treating seed, seedlings, and male strobili with colchicine. The report is divided into three main parts:

1. Treatment of seed and seedlings of slash pine, *Pinus elliottii* Engelm. with colchicine.
2. Culture of slash pine embryos on colchicine-enriched agar.
3. Treatment of male strobili of three species of pine with colchicine during meiotic and post-meiotic divisions (Loblolly pine, *Pinus taeda* L., Austrian pine, *Pinus nigra*, Arnold, and Mugo pine, *Pinus mugo*, Turra.).

Review of Literature

After Blakeslee and Avery's report (*2*) on their successful induction of polyploidy in plants, similar investigations were started throughout the world, and Mirov and Stockwell (*20*) probably can be credited with the first induction of polyploidy in a forest tree. No attempt will be made here to review all the studies with colchicine; only those reports are cited which had a direct bearing on the methodology used in this study. The reader who desires more information on this subject is referred to the comprehensive literature review by Dermen (*3*), and to the recent book, *Colchicine in Agriculture, Medicine, Biology and Chemistry*, by Eigsti and Dustin (*7*).

Colchicine acts on the spindle fiber mechanism during mitosis and arrests normal cell division at metaphase. Without these spindle fibers the chromosomes fail to move in an organized manner and become scattered throughout the cell. After separation the chromosomes pass through a telophase, and eventually a membrane is formed around the nucleus which, at this stage, has twice the original number of chromosomes (*7*). Therefore, colchicine is only effective on actively dividing cells, which accounts for the fact that most of the treating methods are very similar. In general, active tissue is treated, and optimum conditions for cell-division are maintained throughout the treatment period.

Colchicine has been effectively applied in an aqueous solution (*20, 9*), a glycerine solution (*5*), in agar (*23, 8*), or in a lanolin paste (*21, 24*). Depending on the type of treatment and plant material, the concentrations have been varied with good results from 0.05 percent (*6*), to 2.0 percent (*24*). Similarly, the period of treatment has ranged from a few hours up to 25 days.

The most common method is to treat the seed, either before germination or during germination, by soaking it in colchicine under atmospheric or reduced pressures, or by germinating it on filter paper which is moistened with the colchicine solution. This was done for pine (*20, 6, 9*), redwood (*12*), Japanese cypress (*14*), spruce and larch (*10*), and birch (*13*). The seed was conditioned in various ways: stratified, seed coat or endosperm removed, and grown on either soil or sand, or on enriched agar.

With some plans, treatment of the growing shoot has been successfully used, as in sugar beet (*23*), pea (*25*), white clover (*1*), cranberry (*4*), pears (*5*), apple (*8*) and pine (*9*). Working with rice, Luong (*15*) found it necessary to split the growing point of the freshly germinated seedling before treatment with colchicine.

Pollen with more than the haploid number of chromosomes has been obtained by treating the flowers either before or during meiosis, but most of these pollen grains were abortive (*23, 11*).

The over-all changes in the colchicine-induced polyploids in the different plant species are very similar and can be summarized as follows: the leaves or needles become thickened and are few in number, the cells are larger but the number produced is smaller, the foliage is dark green, the branches are coars-

er, the guard cells are larger which results in larger stomates, and dwarfing of the plant is common. The root system is often unable to grow, but this difficulty has been overcome in a few instances by grafting polyploid seedlings on normal diploid seedlings (*19, 9*).

Unless polyploidy is induced at a very early stage, mixoploid plants are produced. Also, the meristems of the polyploids have a tendency to revert to a diploid condition, either *in toto*, or they produce side branches with diploid cell complements. Some of the treated polyploid forest trees, however, maintained their polyploid condition to the stage where they produced viable pollen and fertile female flowers (*26, 13*). Johnsson (*13*) successfully used two tetraploid birch trees, which he had obtained by colchicine treatment, as female parents to produce triploid progeny. After one year, these triploids were slightly shorter, but had the same diameter as the diploid seedlings.

Treatment of Slash Pine Seed and Seedlings

Materials and Methods

A. Treatment of seed.—1. Seed which had been stored under dry conditions in a refrigerator until used was soaked in aqueous colchicine in concentrations of 0.1, 0.2, 0.4, and 0.5 percent at a temperature of 6°C. One hundred seeds were treated with a 5 cc volume of the solution for periods of 1, 2, 3, 5, 10 and 20 days.

2. Seed that had been stratified in a refrigerator for 20 days was treated in the same manner as under 1.

3. Seed which had been stratified in the refrigerator for 45 days was mixed with finely ground peat moss and placed in a covered glass dish. The moss was soaked with colchicine solutions in concentrations of 0.05, 0.1, 0.2, and 0.4 percent, and the seeds were allowed to germinate under room temperature in this mixture. The seedlings were removed from the peat moss once they had germinated, and 250 seeds were used for each concentration.

B. Treatment of freshly germinated seedlings.—1. Seed was allowed to germinate and when the root was about 2.5 cm. long the seedlings were removed and treated. The roots were extended through holes in a wire screen so that the tip of the root projected into a dish of water. A pad of cotton, soaked in the colchicine solution, was placed on top of the seedling (Fig. 1*A*). Treatment took place at room temperature for 1, 2, 3, and 4 days, with colchicine concentrations of 0.1, 0.2, 0.4, and 0.5 percent. Thirty seedlings were used in each treatment.

2. Using the same procedure as under 1, seedlings were treated in a refrigerator (6°C) with colchicine concentrations of 0.2 and 0.4 percent, for 1, 2, 3, 5, and 10 days, and with 0.5 percent for 1, 2, 3, and 4 days.

3. Freshly germinated seeds were placed in a trough so that the cotyledons and growing point (still covered by the seed coat) were submerged in a colchicine solution and the root tip extended into water. Special troughs had been fashioned with paraffin in Petri dishes (Fig. 1*B*), and 0.4 percent colchicine solution was used for 1, 2, 5, and 10 days. The dishes were placed in a large Petri dish to prevent the evaporation of the colchicine, and they were kept in a refrigerator (6°C) throughout the treatment period. Fifteen seedlings were used for each treatment.

4. Seedlings with a total length of 2.5 to 7.5 cm. were used for this treatment. Their roots were placed in holes in a block of 1.5 percent agar, and a thin layer of 2.5 percent agar was poured around the seedlings to seal the roots and protect the root tips from being af-

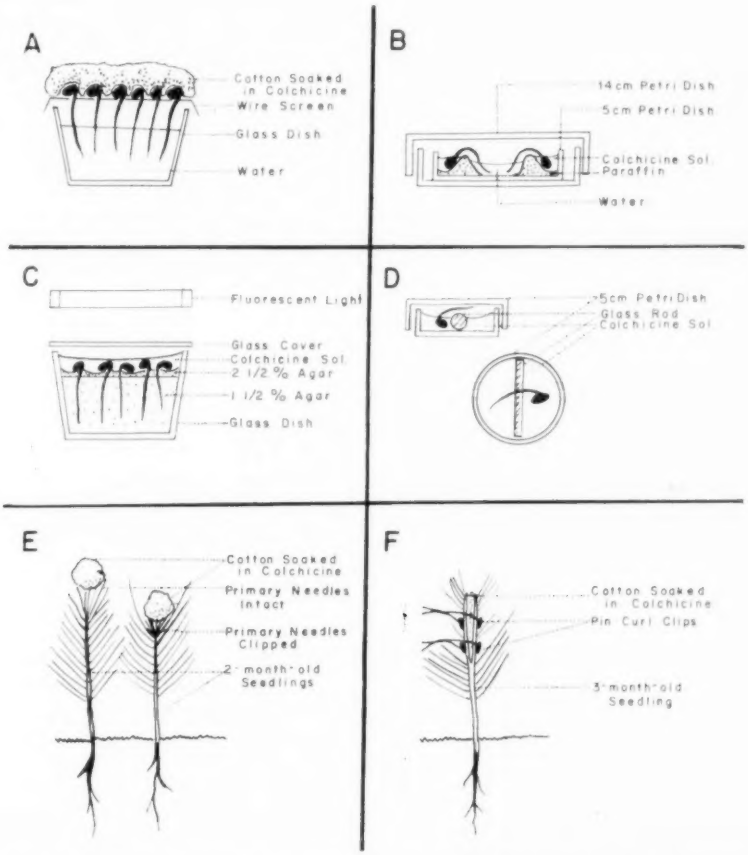

FIG. 1.—Schematic illustrations of several of the treating techniques. *A* Wire-screen method (B1+2). *B* Paraffin trough placed in Petri dish (B3). *C* Roots sealed in block of agar (B4). *D* Radicle supported by glass rod (B7). *E* Cotton placed on primary needles (C2). *F* Tip of seedling slit with a razor (C3).

TABLE 1.—PERCENTAGE OF SURVIVING POLYPLOID SEEDLINGS PRODUCED BY TREATING THE SEEDLINGS BY THE WIRE SCREEN METHOD, EXPRESSED AS A PERCENT OF TOTAL NUMBER OF SEEDLINGS SURVIVING AFTER 3 WEEKS

Colchicine (Percent)	Room temperature Treatment period (Days)				Refrigerator Treatment period (Days)			
	1	2	3	4	1	2	3	4
0.1	2.8	—	—	3.5	—	—	—	—
0.2	3.8	—	13.2	7.4	4.3	—	—	—
0.4	15.2	20.0	3.8	21.0	—	27.0	8.0	25.0
0.5	6.5	13.5	20.6	39.3	1.9	20.0	31.3	42.9

fected by the colchicine. The part of the seedling which protruded above the surface was immersed in colchicine solutions of 0.2 0.4, and 0.6 percent for 1, 2, 3, and 6 days (Fig. 1*C*). Twenty seedlings were used in each treatment, and they were kept under constant daylight fluorescent illumination (800 foot candles).

5. Seed was germinated in Petri dishes on moist filter paper until the root tips became visible. Colchicine in concentrations of 0.1, 0.2, and 0.4 percent was then added and germination was allowed to continue at room temperature for 1, 2, 3, 4, and 5 days. Fifteen seedlings were used per treatment.

6. The same procedure as under 5 was carried out for dishes placed in a refrigerator (6°C) for 1, 2, 3, 5, and 10 days.

7. Freshly germinated seedlings were placed in 5 cm. Petri dishes so that their cotyledons and growing tips were submerged in a colchicine solution and the root tips were supported out of the solution by a glass rod (Fig. 1*D*). The dishes were placed in a refrigerator (6°C) for 1, 2, 3, 4, 5, and 6 days, and colchicine concentrations of 0.1, 0.2, 0.4, and 0.5 percent were used. Ten seedlings were treated under each condition.

C. Treatment of seedlings.—1. The apical growing point of three-week-old seedlings were treated with colchicine concentrations of 0.1, 0.2, and 0.5 percent for periods of 1, 3, and 10 days. A small pad of cotton was placed on the growing point, and the cotton was kept moistened with several applications of solution during the day. On one half of the seedlings the primary needles which had started to form were clipped. Ten seedlings were treated under each condition.

2. The growing points of three-month-old seedlings which were growing in individual pots were treated in the same manner as under 1 (Fig. 1*E*).

3. The upper part (2 cm.) of three-month-old seedlings was split with a razor, a piece of absorbent cotton soaked wth a colchicine solution was placed in the slit, and the two halves were held together with wire clamps (Fig. 1*F*). The seedlings were treated with 0.2 and 0.4 percent aqueous colchicine for 1, 2, and 3 days, with three replications for each treatment. After the treatment period, the cotton was removed and the split parts were clipped together.

Results

Unless stated otherwise, the chromosome number of a putative polyploid seedling which was detected by its over-all appearance was determined on meristematic needle tissue. Squashes were prepared according to the method of Mergen and Novotny (*17*), and idiograms were drawn with a camera lucida or a projection mirror under a magnification of approximately X2000. Throughout this report, whenever the term polyploid is used, it refers to seedlings or cells whose chromosome count has been determined to be a multiple of (n),[1] and greater than (2n).

A. Seed treatment.—From a total of 6,000 seeds which were treated by soaking in colchicine, only 16 seedlings (0.27 percent) remained polyploid after 6 months. There was no pattern as to the effect of concentration or period of treatment, and the polyploids appeared to be randomly distributed among the treatments. There was also no significant difference between the germination rates of the seed lots as a result of the colchicine, and stratification did not effect seedling behavior.

Of the 1,000 seeds which were germinated in treated peat moss, 22 (2.2 percent) seedlings remained polyploid after 6 months. Of these, 3 resulted from treatment with 0.2 percent colchicine, and 18 from treatment with 0.4 percent colchicine. Most of the seedlings treated in 0.4 percent colchicine had polyploid radicles right after treatment, but the majority of these were either unable to survive or they reverted to a diploid condition within a few weeks.

B. Treatment of freshly germinated seedlings.—Of the methods tested, the "wire-screen" (Method B1, Fig. 1*A*) gave the best results. Of a total of 912 treated, 125 (13.5 percent) seedlings were polyploid right after treatment. After four months, 110 had reverted to diploid and appeared to be normal in all respects, but the remaining 15 (1.6 percent) were still polyploid after 6 months. Although the treatment at room temperature brought about a greater number of abnormal seedlings, the survival of those treated in the refrigerator was much greater, due to the retarded growth during the treatment period. As can be seen in Table 1, the majority of polyploids was obtained by the treatment at higher concentrations and for longer periods, but there was a great deal of variation among the various treatments.

Eighteen (30 percent) seedlings of the 60 seedlings treated in the trough were abnormal. Of these, 14 (22.3 percent) had originated from treatment with 0.4 percent colchicine for five and ten days. After four months all of those which had survived were diploids. Throughout the treatment it was difficult to keep the cotyledons submerged in the colchicine solution; they either tended to float, or the hypocotyl or the radicle pushed the top out of the trough.

The treatment in agar was a complete failure. Sealing the roots in agar, along with the subsequent

[1] *Editor's note.*—The symbol used to designate a single set of chromosomes in the nucleus, or half the number (2n) normally occurring in vegetative cells.

treatment with colchicine, was lethal for all seedlings. Death was probably caused by lack of oxygen.

Of the 2,000 seedlings treated on filter paper at room temperature, 71 (3.5 percent) remained polyploid after three months, with the majority arising from treatment with 0.4 and 0.5 percent for 4 or 5 days. Only 7 of the seedlings treated in the refrigerator were polyploid. Subsequent survival of all the seedlings treated on filter paper was low, probably because the root tips were damaged by the colchicine.

Seven (1.45 percent) of the 480 seedlings treated by the rod method developed into polyploids. All were obtained from treatment in 0.4 and 0.5 percent colchicine for varying lengths of time. During the treatment many of the seedlings changed their intended position, which caused the tops either to be above the colchicine solution or the root tips to dip accidentally into the solution. A high mortality of the seedlings resulted.

C. Treatment of seedlings.—Treating the growing points of 240 three-week-old seedlings resulted in 32 (13.3 percent) abnormal seedlings. This abnormal growth varied from the swelling of individual needles, to the formation of polyploid shoots. Three months after treatment all the new tissue had a diploid chromosome complement. The temporary polyploid condition was evenly distributed among the various treatments.

Of the 240 two-month-old seedlings treated, 59 (24.6 percent) showed abnormal conditions, and 5 had formed polyploid shoots after one month. Only 6 of the seedlings which had not been wounded developed abnormal features, and one of these was polyploid. As with the three-week-old seedlings, all the new tissue produced two months after the treatment was diploid.

The split top of the seedlings did not grow back together after the cotton was removed because the wounds were covered with a dead layer of cells, and the wounds had started to callus. Of the nine seedlings treated with 0.5 percent colchicine, two produced polyploid shoots and both are still polyploid after more than one year.

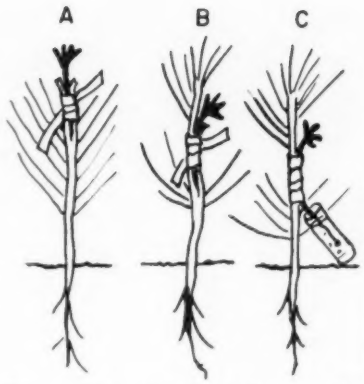

FIG. 2.—Schematic illustration of the three grafting techniques. *A* Top-cleft. *B* Side-slit. *C* Bottle-graft.

Grafting of Polyploids

Because most of the polyploid seedlings which were produced died as a result of their inability to produce an effective root system, abnormal seedlings were grafted on healthy diploid slash pine rootstock. The scions consisted of three-week-old seedlings which showed moderate to extreme abnormalities, and some were obtained by germinating and growing the seedlings in peat moss which was saturated with 0.4 percent colchicine (item 3 under *Treatment of seed* above). Three types of grafts were used: top-cleft, side-slit, and bottle-graft (Fig. 2). Actively growing slash pine seedlings, approximately two months old, were employed as stock. The grafted plants were kept in a cool, darkened room for two weeks after grafting to minimize the grafting shock, and they were individually covered with glass jars to maintain a high humidity around the scion (*16*). After this initial period, they were moved into a greenhouse and placed in a sweatbox until the union had formed. Once the graft was well established the plants were moved to an open bench, and placed under a 16-hour photoperiod.

Of a total of 130 attempted micrografts, there were 50 successful grafts after four months. Most of these failures occurred because some of the abnormal seedlings, although still green and succulent, did not form a union, and the callus growth from the healthy stock plant lignified before it had united with the cells of the scion. After 14 months, 9 of the scions were still polyploid. The height of these grafts is quite variable and ranges from 2 cm. to 25 cm., and each graft has a different appearance (Fig. 3).

Morphology of the Polyploids

Gross morphology.—The very abnormal polyploid seedlings that were verified by smears to be either tetraploid or octoploid, had thickened cotyledons which had a tendency to grow in a spiral. When polyploidy took place before the

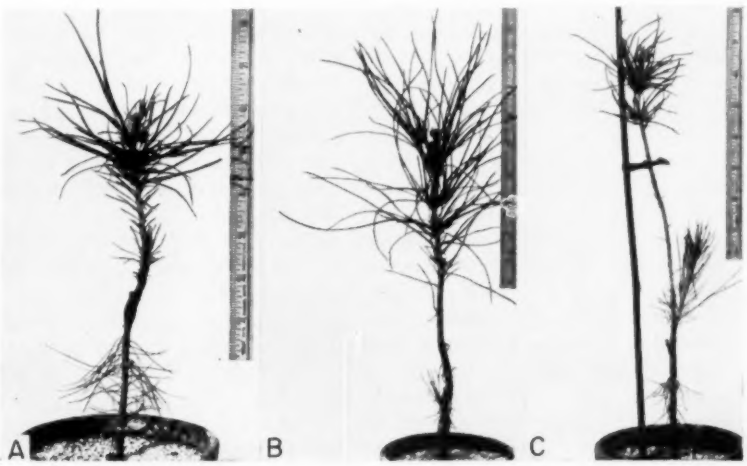

FIG. 3.—Mixoploid slash pine scions on normal stock, 10 months after grafting. Scions were obtained by treatment A3. *A* Scion has 3n+4n cells. *B+C*. Scions are triploid (3n).

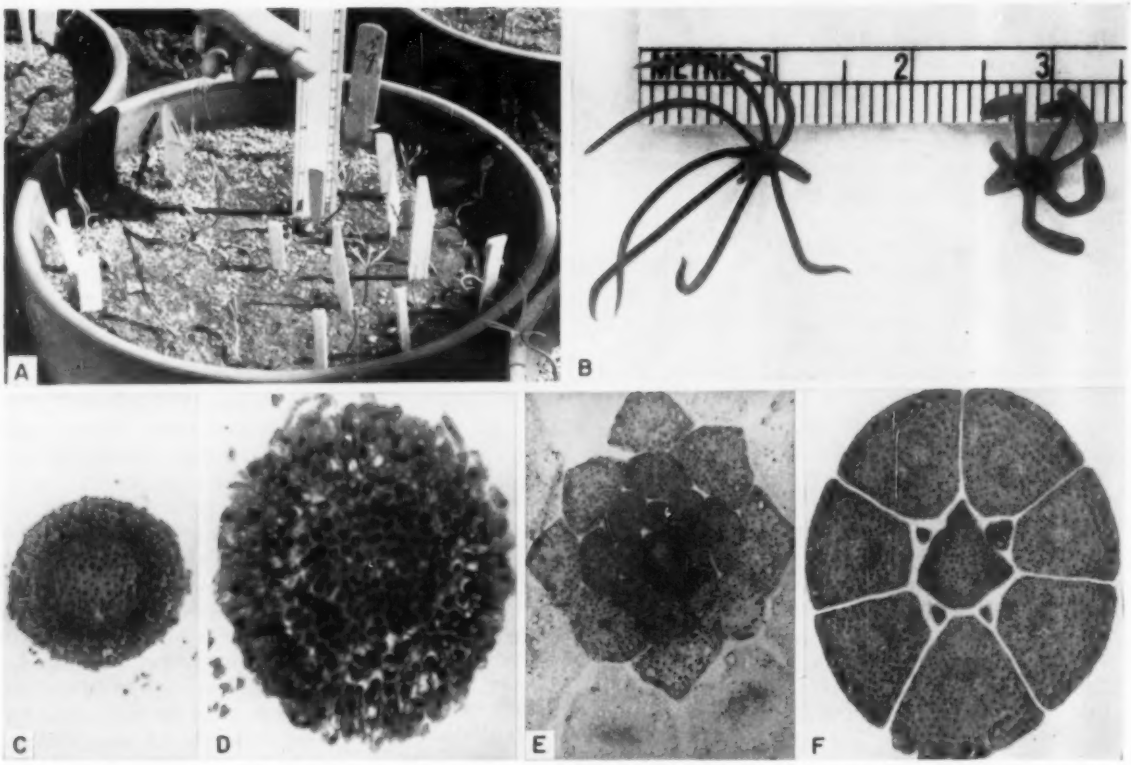

FIG. 4.—Effect of colchicine treatment on growth of slash pine seedlings. *A*. Seedlings treated with 0.5% colchicine for 4 days by the wire-screen method, one week after treatment. *B* Comparison of cotyledons of control (left), and colchicine-treated slash pine (right). *C+D*. Cross-section through growing point of radicle of control (*C*) and polyploid (*D*) seedling (same magnification). *E+F*. Cross-section through growing point of control (E) and polyploid (*F*) seedling. Both seedlings are of the same age. The development of the polyploid is retarded (same magnification).

seed coat had been shed, the enlarging cotyledons were unable to split the integument and separate the two halves of the seed coat. Unless the seed coat was cut loose and removed, the seedling died. In addition, the stored food in the "endosperm" tissue was not utilized by the developing embryo when the seed was placed in a medium which contained colchicine. The radicles were swollen and ended in a knob, but the number of cells in cross-section was about the same in diploid and tetraploid roots, with the cells in the tetraploid roots being larger (Fig. 4*C* and *D*). Some were able to develop a diploid root primordium from cells which were located a few mm. above the root tips. In these instances, the diploid root developed to the extent that it was able to support the growth of the seedling.

The needles were dark green with a bluish hue, and the cotyledons and primary needles especially were shorter and thicker than those of diploid plants (Fig. 4*A*, *B*, *E*, and *F*). The terminal buds were enlarged and on most plants had the appearance of a knob. Secondary needles on the various polyploids were most variable: some were long and thick, some were short and thick, while on some plants the needles within the fascicles had fused together. The secondary needles were slow to appear and often had a tendency to curl. This diversity of growth patterns is illustrated in Figure 5. The overall height growth was depressed in all instances, and the tallest polyploid seedling was 57 cm. after 18 months, as compared to an average height of 70 cm. for the controls.

The cells of the polyploids were larger and irregular. This irregular pattern was especially pronounced in the arrangement and the size of the stomates. The number of stomates was counted on 25 normal and 25 polyploid needles on the outer and inner surface of primary needles within a 4 mm.^{2} area located in the middle of the needle. The average number per mm.^{2} for the normal seedlings was 81.6 $\pm$ 2.18 as compared to 47.8 $\pm$ 2.60 for the polyploid needles. On each of these 25 normal and 25 polyploid needles the guard cells of 10 stomates were measured. The average length and width of a diploid guard cell was 57.8$\mu\pm$.41μ and 20.73$\mu\pm$.19μ and for the polyploids 67.4$\mu\pm$.50μ and 26.1$\mu\pm$.20μ respectively.

Chromosome counts.—Right after treatment in colchicine all the abnormal seedlings were mixoploids, the chromosome number within an individual ranging from 2n to 8n. This mixoploid condition stabilized after a few weeks, and the seedlings either reverted to diploids, or stabilized at either 3n, 4n, or a mixture of 2n, 3n, and 4n. Those seedlings which showed the greatest degree of abnormality after the treatment tended to remain 3n or 4n. Several

of the mixoploids produced a chimaeric polyploid side-branch and resumed their normal ploidy for the balance of the shoot (Fig. 5*H*). Other individuals were sectional chimaeras, producing diploid needles on one side of the shoot and polyploid ones on the other half. As mentioned before, a large number were able to initiate a normal diploid root from the tissue above the polyploid growing knob; in these instances this new root allowed the polyploid shoot to survive.

Culture of Slash Pine Embryos on Colchicine-enriched Agar

Slash pine embryos were grown on colchicine-enriched agar so that the seedlings could be treated at the earliest possible stage of their development. Embryos were excised aseptically from seeds which had been stratified for 60 days, and placed on Bacto Yeast Morphology Agar.[2] Colchicine was added to the agar in concentration of 0.01, 0.05, and 0.10 percent.

Experimentation and Results

After the seeds were removed from the material in which they were stratified, they were soaked for five minutes in saturated aqueous bromine solution to which detergent had been added. They were then rinsed in sterile water, the seed coats were removed, and the seeds were then submerged in undiluted "Chlorox" solution for 15 minutes. After this, the embryo was removed with sterile instruments and placed on an agar slant in a culture tube. The tube was either stoppered with a cotton plug and capped with "Saran Wrap," to retain the moisture, or covered with aluminum foil. The cultures were placed in an incubator at 25°C under daylight fluorescent light (600 foot candles) and subjected to a photoperiod of 16 hours.

A. 0.01 percent colchicine.—Of 18 embryos which were cultured,

[2]Trade name of DIFCO Laboratories, for agar preparation containing a carbon source, amino acids, vitamins, trace elements, and major elements.

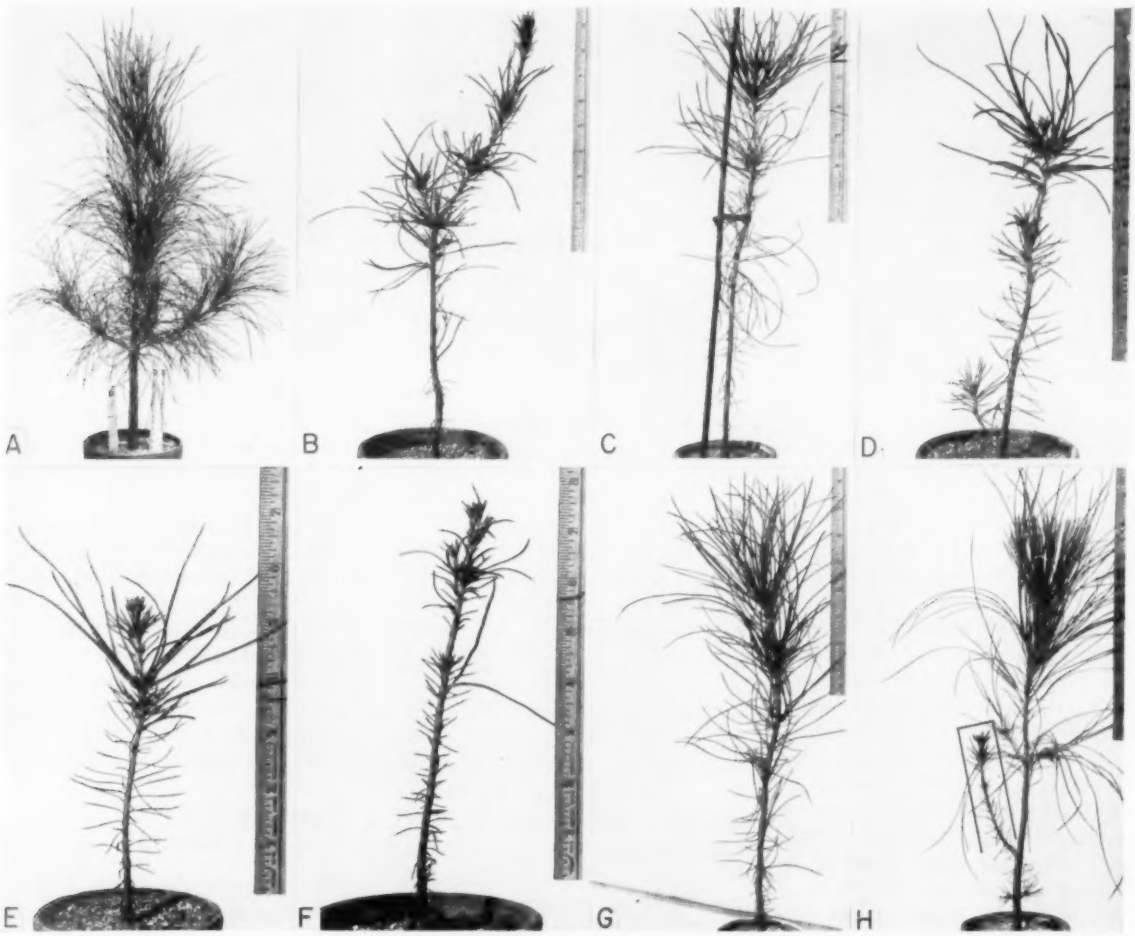

Fig. 5.—Appearance of 14-month-old polyploid slash pine seedlings as compared to a normal diploid plant. *A* Normal diploid (2n), (2 years old). *B* Mixoploid (2n+3n) seedling obtained by method C1; 0.1%; 10 days. *C* Mixoploid (2n+3n) seedling as a result of treatment B5; 0.2%; 5 days; room temperature. *D* Triploid (3n) seedling (A3; 0.4%). *E* Tetraploid (4n) seedling (B5; 0.4%, 4 days; room temperature). *F* Mixoploid (2n+3n) seedling (B2; 0.4%; 5 days; refrig.) *G* Triploid (3n) seedling (B1; 0.5%; 4 days; room temperature). *H* Chimaeric seedling (B1; 0.5%; 3 days; room temperature). Upper shoot 2n, side shoot 3n+4n.

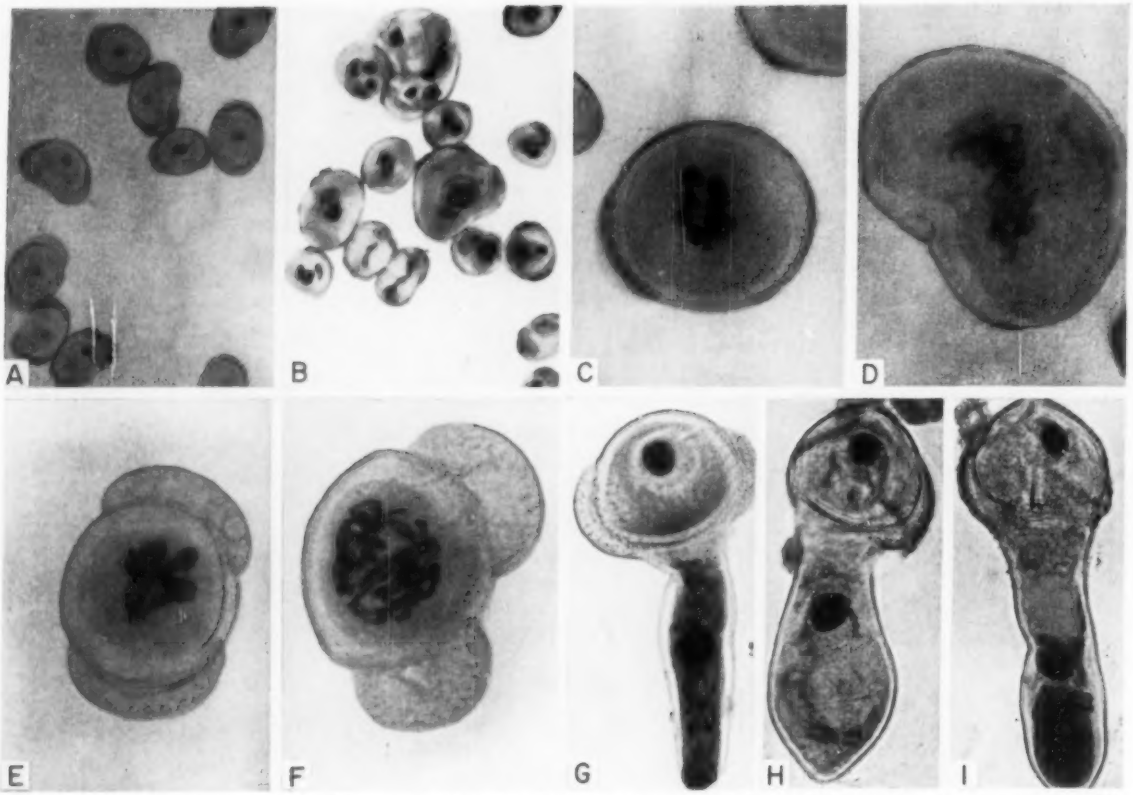

FIG. 6.—Effect of treatment of the microspore mother cells with colchicine. *A—D.* Austrian pine. *A* Normal microspores. *B* Microspores resulting from treatment of the microspore mother cells with 1.0% colchicine. *C* Normal microspore in first vegetative metaphase. *D.* Colchicine treated microspore diad in the second division. Note abortive partition wall. *E—I.* Mugo pine. *E* Normal (haploid) microspore. *F* Colchicine-treated (diploid?) microspore in vegetative metaphase. *G* Normal germinating pollen grain. *H+I.* Germinated pollen, resulting from microspores which were treated with colchicine, having enlarged tubes. The magnifications of the paired comparisons in Figure 6 are the same.

13 started to develop chlorophyl and were green after three days. They remained green for up to 10 days, after which time they began to degenerate. Only one of the embryos started to form a radicle. The part of the embryos in contact with the agar was swollen, and tended to become necrotic. As indicated from a squash of the developing radicle, some of the cells were polyploid, and the highest ploidy present was 8n.

B. 0.05 percent colchicine.—Of 22 embryos cultured, 6 become contaminated and died, but the remaining ones developed chlorophyll after one week. There was extensive swelling and distortions of the seedlings, especially at the points at which they were in contact with the agar. The rudimentary cotyledons did not grow in length but became swollen and the radicle only formed a knob. The chlorophyll disappeared gradually and was replaced by a red pigment. After 30 days all the embryos had died and no chromosome counts could be made.

C. 0.10 percent colchicine.—Twenty embryos were excised and implanted on the agar containing 0.10 percent colchicine. The surviving embryos had an enlarged hypocotyl, but no roots were formed. Instead of developing chlorophyll, all the embryos were red in color, and started to turn chocolate-brown. After 50 days the embryos showed no further sign of growth. Chromosome counts in several of these indicated them to be polyploids, with a maximum number of 96 chromosomes in one cell.

D. Controls.—Excised embryos were placed on the enriched agar with no colchicine added to it. All of these grew vigorously for the first five days, and continued growth, although at a reduced pace, for the remainder of the 30-day period.

In addition to these, some were grown in agar or moist sand to which an aqueous "endosperm" extract had been added. Some of these embryos developed into normal-looking seedlings. The largest of these seedlings had a root which was 3 cm. long, and its primary needles grew to 1.5 cm. before it became dormant.

Treatment of Developing Male Strobili

To obtain diploid pollen of loblolly pine, Austrian pine, and Mugo pine, immature male strobili were treated with colchicine. The strobili were treated when the microspore mother cells had started their meiotic division.

Methods

A. Loblolly pine.—Branches of loblolly pine bearing immature male flowers were collected in the Olustee, Florida, area during the period of January 30, to February 5. The needles were stripped from the branches and the clusters of male flowers were immersed in Coplin jars containing either 0.2 or 0.5 percent aqueous colchicine. They were treated inside a desiccator under reduced pressure (½ atm) for periods of 30, 45, 60, 75, and 90 minutes. The colchicine was heated to 40-50°C. to facilitate the penetration of the solution into the resin-covered catkins.

Thirty branches were treated, three replications for each combination of time and concentration.

The excess colchicine solution was washed off after the treatment and the branches were bottle-grafted onto slash pine stock.

B. Austrian pine.—Branches bearing immature male catkins of Austrian pine were grafted during late winter 1957 on potted root-stock. They were moved into a greenhouse during the later part of March, and when some of the microspore mother cells within a cluster had started their meiotic division, the entire cluster was treated. The protective scales were removed from the aments on one side of the cluster, while the remaining half remained untouched for control. Absorbent cotton was placed between and around the trimmed catkins, and the cotton was kept soaked with 1.0 percent aqueous colchicine for ½ or 2 hours. The treatments were applied between 11:00 a.m. and 2:00 p.m. when the temperature in the greenhouse ranged between 23° and 26°C. A total of six clusters were treated in this manner.

C. Mugo pine.—Clusters of male Mugo pine flowers were treated in the field during the later part of April and early part of May. When a cluster was ready for treatment, the branch was stripped of its needles, and a vial was fastened over the catkins. The branch was bent down, and enough colchicine solution was poured into the vial to cover the catkins. The treatments were carried out during the warmest part of the day, and the vials were directly exposed to the sunlight. A 1.0 percent aqueous colchicine solution was applied for a period of ½, 1 hour, and 2 hours, and a 0.5 percent solution for 1, 1-½, 2, 3, and 4 hours. Each treatment was repeated on five clusters of catkins, and after the vials were removed, the catkins were sprayed with distilled water.

Results

Loblolly pine.—All of the treated flowers developed to the tetrad stage, and then began to degenerate. The catkins kept on elongating on some of the clusters, but the pollen from both the treated and untreated ones aborted before it reached maturity. One single treated catkin yielded a small number of pollen grains. The pollen appeared normal in appearance, but failed to germinate when cultured in double distilled water. A large percentage of successful unions was obtained and the subsequent development of the scions was normal. One scion grew a total length of 1.35 m. during the first year after grafting.

Austrian pine.—Of the six Austrian pine clusters treated, only one cluster developed far enough to shed its pollen, the rest aborted, most probably because of the failure of the graft to supply the necessary food to mature the microspores. Microspores were obtained from the catkins treated with 1 percent colchicine for 1 hour. Some of these were larger than the untreated ones (Fig. 6*A*+*B*), and their shape was irregular with an uneven number of nuclei. The wings were missing in most instances. In some of the grains, chromosome configurations could be observed and some had a larger number than the untreated ones (Fig. 6*C*+*D*). Ten germination cultures (double distilled water) were prepared and incubated. After seven days, none of the pollen from the grafts either treated or untreated, had germinated. The average percentage of abnormal pollen grains in these cultures, as judged by their larger and irregular shape, was 17 percent.

Mugo pine.—All of the treated Mugo pine flower clusters survived and shed some pollen, but their maturity was delayed from two days to a week. After the catkins had been treated, aceto-carmine smears were made daily to check on the developing microspores. In several instances a diploid number of chromosomes was observed while the cells were in either their first or second vegetative divisions. A comparison can be made of this condition between Figure 6*E* and 6*F*. After the pollen was extracted it was stored in a desiccator (25 percent R.H.) and placed in a refrigerator (4°C) until germination was evaluated. Duplicate cultures in double-distilled water, using the hanging drop method in a Van Tieghem cell, were incubated at 26°C. The average values from this germination study are given in Table 2.

The pollen tubes of these abnormal (diploid?) grains were much wider, and some had a pronounced swelling close to the growing point. The generative and tube nuclei of the treated and untreated pollen were of similar size and the tube

TABLE 2.—EFFECT OF TREATMENT WITH COLCHICINE ON THE GERMINATION OF MUGO PINE POLLEN

Treatment	Abnormal pollen	Germination	
		Abnormal	Normal
	Percent		
Control			90
1%; ½ hour	20	13	75
1% 1 hour	25	20	69
1%; 2 hours	43	15	81
0.5%; 1 hour	36	18	34
0.5%; 1 hour	23	36	56
0.5%; 2 hours	17	26	64
0.5%; 3 hours	14	50	62
0.5%; 4 hours	45	0	14

nucleus moved into the pollen tube at the same time. In general, elongation of the tube of the treated pollen was depressed, although some of the abnormal grains had a longer tube than the untreated ones (Fig. 6*G*, *H*+*I*).

Discussion and Conclusions

Treating the seed with colchicine during the pre-germination period resulted in a low number of polyploids probably because the embryos were in contact with the colchicine at a time when no mitotic division took place, and only the residual traces of colchicine were effective. On the other hand, when the seed was allowed to germinate in peat moss which was saturated with colchicine, a greater number of polyploids were obtained. The peat-moss method, and modifications thereof, should be quite successful with most conifer species, as it allows the seed to germinate in an excellent germination medium, while the entire seed coat is in contact with the colchicine but the oxygen supply to the dividing embryo is not cut off. In all of the treatments which apply to seed and freshly germinated seedlings, the embryo is either submerged in the colchicine solution, or only a thin film covers the seed as a result of surface tension.

On the bases of the evidence from this study and from previous experiments, it appears that best results will be obtained if the germinating seed or seedling can be kept under conditions of optimum growth during the treatment. With pines at least, colchicine should be prevented from touching the radicle or root during the treatment period. The treatment of the plumule, by necessity, will not yield uniform polyploids, but seedlings whose root system is diploid and the shoot polyploid. The chances of obtaining a large number of polyploid individuals by embryo culture appear to be small, because the entire embryo, including the radicle, is in contact with the colchicine. With colchicine it is very easy to obtain polyploidy in dividing cells, but the problem is to devise a satisfactory method of isolating and perpetuating the polyploid tissue.

Of great potential are the methods which induce doubling of the chromosomes either during meiosis or during mitotic divisions of the gametophytes. This will shorten the waiting period needed to obtain reproductive structures with doubled chromosome numbers, and should allow the production of both triploid and tetraploid plants with stable chromosome complements.

The over-all symptoms of polyploidy in slash pine seedlings were entirely similar to those in other plants which were treated with colchicine, and to natural polyploid slash pines (*18*). The abnormal condition varied from dwarfed and swollen radicles, hypocotyls, cotyledons, and needles, to almost normal seedlings with slightly thickened ends of the cotyledons. The needles, especially, were often of the *gigas* type, along with some of the terminal buds which gave the appearance of swollen crowns. The seedlings whose roots were in contact with the colchicine often formed root tumors (C-tumors) close to the growing tip; seedlings with tumors were unable to survive. One reason for the failure of these club-shaped polyploid roots to survive, appears to be caused by microorganisms. The succulent condition which is probably accompanied by weakened cell walls makes these cells easy prey. In some instances, this was overcome by grafting the hypocotyl and cotyledons, under more or less aseptical condition, on vigorous diploid plants.

The gross abnormalities of the treated seedlings were helpful in selecting the seedlings for chromosome counts, but the abnormal conditions were not sure indices of their polyploidy. Neither could the size of the guard cells, nor the nuclei of other cells be considered reliable criteria in determining the polyploidy of a cell or plant. On the other hand, the doubling of the chromosome number in a nucleus was invariably accompanied by morphological changes of the tissue or plant, and the effect of the treatment varied considerably, depending on the stage of growth.

Immediately after treatment, the formation of the peculiar "C-pairs' of the chromosomes, typical for colchicine treatment, were observed in a large number of cells. These "C-pairs" have the appearance of pairs of skis and are found throughout the dividing nuclei (Fig. 7*B*, *C*+*D*). Although cells with higher ploidies were present, the largest verified number was 8n (Fig. 7*L*). Very often within the same field of view in the microscope, cells with 2n, 4n, and 8n, chromosomes were observed (Fig. 7*F*, *K*, *L*). Once the colchicine effect was gone, cells resumed their normal mitotic divisions with the doubled number of chromosomes (Fig. 7*M*). As mentioned under "Results," many of the polyploid plants reverted to diploid growth. It was not the polyploid cells *per se* that reverted to diploidy, but the polyploid cells divided at a slower rate and were swamped by the faster-growing diploid cells which surrounded them. As a result, two general types of plants were formed: mixoploids and chimaeras. In the mixoploid plants the polyploid cells appeared in an unorganized manner, while the chimaeras had either a polyploid shoot or a section of the stem which was entirely polyploid.

By treating immature male strobili, the percentage of imperfect tetrads was increased over the normal occurrence. In a large number of dividing microspore mother cells partition walls started to form but aborted, leaving the chromatin from two nuclei within one cell. Although the chromosome number in these larger pollen grains was not verified, it can be assumed that some were diploid. The viable Mugo pine pollen which was obtained will be used in an effort to produce triploid individuals.

None of the slash pine polyploids which were produced have any obvious features which would make them more desirable from a forestry point of view. On the contrary, their outward features make them less desirable, although nothing is known about their ability

to resist insects and diseases. It is encouraging, however, from the evidence with other plants that these anatomical malformations may disappear in successive generations (C_1, C_2, and later generations). As with any other type of tree improvement work, selection from within a large population is the starting step. With these polyploids we are dealing with entirely new genotypes, and a large number need to be produced for each plant species, so that the most promising individuals can be selected for future breeding work.

Summary

Polyploidy was induced in pines by treating seed, seedlings, and male strobili with colchicine.

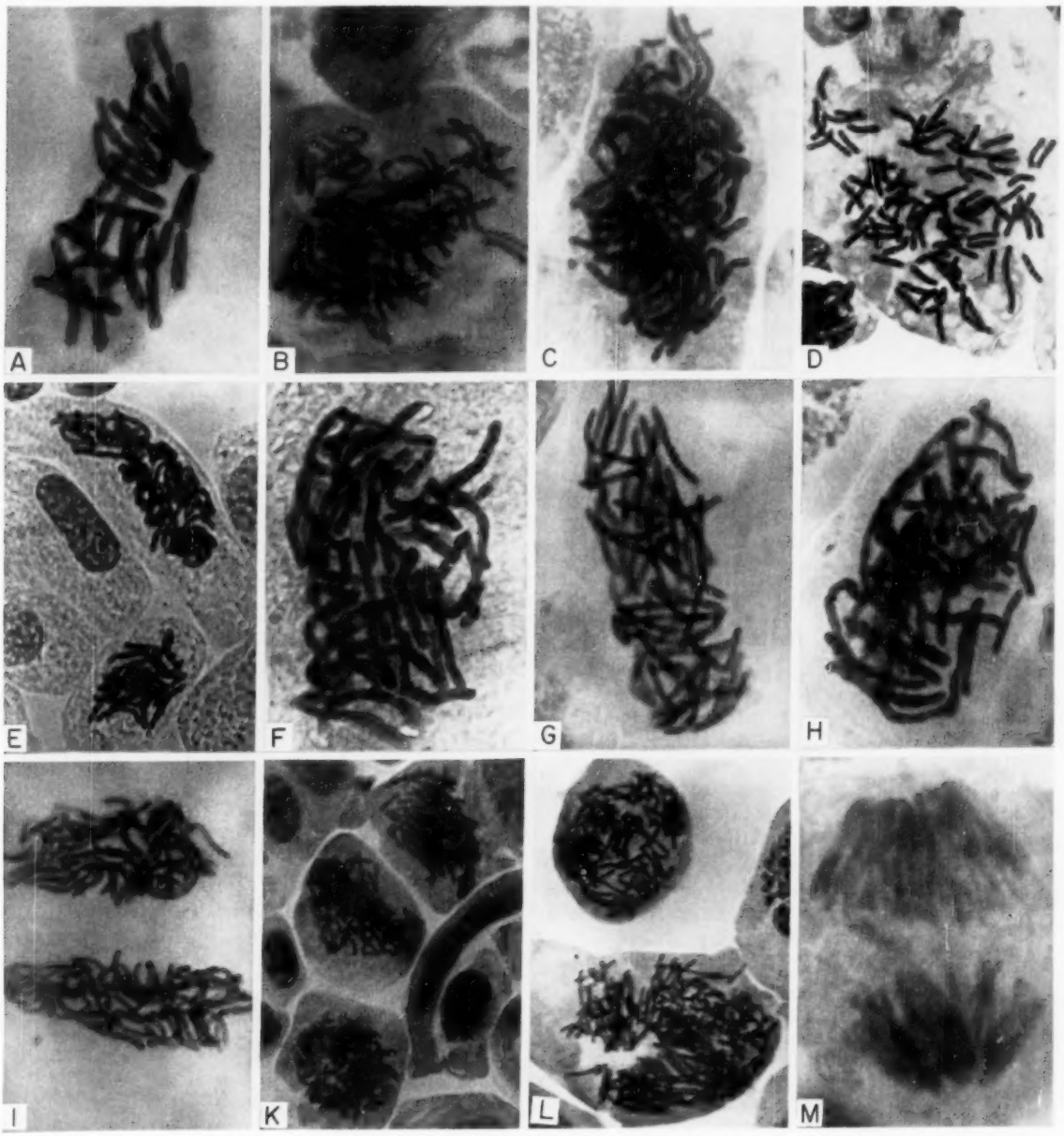

FIG. 7.—Chromosome configurations in diploid and polyploid cells. *A* Normal diploid cell in arrested metaphase (2n=24). *B*, *C*, +*D*. Colchicine anaphase in needle bases showing the separation of the chromosomes without the characteristic attraction to the two poles. Chromosomes in *B* resulted from treatment A1; 0.4%; 2 days, those in *C* from treatment A1; 0.2%; 0.2%; 10 days, and those in *D* from treatment B1; 5%, 4 days, refrig. *E* Diploid (2n=24) and tetraploid (4n=48) cells in the needle base of a seedling treated under C1; 0.5%; 1 day. *F* Tetraploid (4n=48) cell in same seedling as in *E*. *G*. Polyploid cell in scion of graft (A3, 0.4%) after 4 months of growth. *H*+*I* Polyploid cells in radicle after treatment A3, 0.4%. *K*+*L* Mixoploid tissue in the base of a needle (*K*), and in the root (*L*) of a seedling treated under A3, 0.4%. Upper cell in *L* has a verified number of 96 chromosomes (8n). *M* Normal early telophase of a polyploid cell in a needle after the effect of colchicine has disappeared. Seedling had been treated under A2, 0.4%, 10 days.

Three approaches were used: (1) Treatment of seed and seedlings of slash pine, *P. elliotti* Engelm. (2) Culture of slash pine embryos on colchicine-enriched agar. (3) Treatment of male strobili of three species during meiotic and post-meiotic divisions (Loblolly pine, *P. taeda* L., Austrian pine, *P. nigra* Arnold; and Mugo pine, *P. mugo* Turra). The treating methods, along with their effect on the morphology and cytology of the plant material, are described in detail.

Acknowledgments

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Do Foresters Mistake Men for Deer?

In accepting responsibility for wildlife harvests upon forested areas, this department includes the safety of those who reap annual increments of big game. Our studies suggest that apprenticeships served by hunters relate to the safety of other hunters afield.

Observations and inquiries continued over many years, indicate that men termed "foresters" rarely, if ever, mistake and shoot other men for deer, elk, or bear, though a high percentage of foresters within our big game ranges hunt. We hypothesize that men who make almost daily decisions concerning the identity of creatures a-forest, acquire a reliable judgement which minimizes error.

We ask readers of the JOURNAL OF FORESTRY to write us of instances in which foresters have mistaken men for big game, giving details concerning the backgrounds, experience, maturity, and emotional types of individuals involved. Or, if readers have observed a singular freedom from such mishaps within areas known to them, we shall value testimony they can send us.

J. V. K. WAGAR
Department of Forest Recreation and Wildlife Conservation, Colorado State University, Fort Collins

Photosynthesis and Respiration in Colchicine-Induced Polyploid Seedlings of Slash Pine

Philippe F. Bourdeau and François Mergen

THE PRECEDING article (*9*) reports the induction of polyploidy in slash pine, *Pinus elliotti* Engelm., by various colchicine treatments. The resulting polyploid seedlings had a depressed growth pattern and most of the abnormal plants had abortive roots. Their polyploid shoots, however, could be kept alive by grafting them on diploid rootstock. Even under these conditions the growth rate of polyploid shoots was considerably below that of normal plants, which suggested that polyploidy adversely affected the photosynthetic efficiency of needle tissue. This possibility was explored and the results obtained are reported here.

Material and Methods

Shoots that were entirely polyploid, as indicated by their appearance, and by periodic chromosome counts, were used. Their morphology was quite variable, but in general both the primary and secondary needles were thicker and shorter than normal. All of these had been grafted on diploid root stock six to eight months prior to their evaluation and had formed good unions. The controls consisted of diploid shoots of the same age, some of which were grafted on diploid root systems. Preliminary tests had shown that once a graft union has formed it does not significantly affect photosynthesis in the needles.

Determinations were made separately on samples of detached primary needles and on secondary needle fascicles. It has been established that severing the needles does not alter the CO_2 exchange for at least one hour, if the cut ends are placed in a small container of water.

THE AUTHORS are assistant professor of forest ecology and assistant professor of forest genetics, respectively, Yale University, School of Forestry, New Haven, Conn.

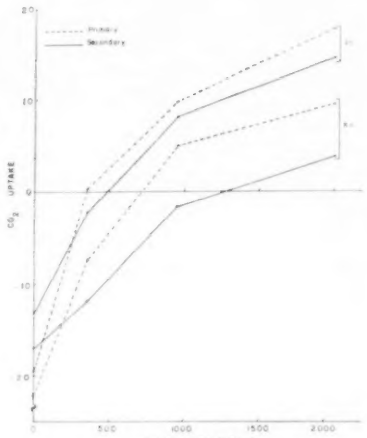

FIG. 1.—CO_2 uptake in micrograms/minute/gram fresh weight at various light intensities, in primary and secondary needles of diploid and polyploid shoots.

The light source was a 700 watt "Fluomeric" lamp and the light intensity reaching the needle tissue was varied by altering the distance to the lamp or by using gauze screens. One foot candle was approximately equivalent to 25 ergs/cm.^{2}/sec. of visible light. The needle samples were placed in a Lucite chamber in which the temperature was maintained at 30°C. ±0.5° by controlling the circulation of cold water through its double top.

Net photosynthesis was measured as CO_2 exchange at three light intensities (330, 950, and 2,000 foot candles), and respiration as CO_2 output in darkness. The Lucite chamber formed a closed system with a Liston-Becker model 15A infrared gas analyzer. Air was circulated in the system at a constant rate of 3 liters/minute, and the CO_2 concentration was maintained close to normal atmospheric content (270 to 330 ppm.). Rates of CO_2 exchange were calculated over periods of a few minutes from the rates of concentration change in the system.

The seedlings were kept in a greenhouse under a 16-hour photoperiod. The determinations were always made in pairs, consisting of a sample from a diploid and a polyploid plant. These plants had been exposed to identical environmental conditions for several months previously and were given a 45-minute induction period at a high light intensity immediately preceding the measurements.

After the measurements of photosynthesis and respiration, representative samples of needles were taken for anatomical observations, and for determination of water content by oven-drying, chlorophyll by spectrophotometry (*8*) and nitrogen by the micro-Kjeldahl method (*2*).

Results and Discussion

Average CO_2 uptake per gram of fresh needles at 330, 950 and 2,000 foot candles, and in darkness, are presented in Figure 1. Each point is the average of 10 or 11 replications except at 330 foot candles, where only five determinations were made for each type of needle. As a group, diploid needles had higher average rates of net photosynthesis than polyploid needles, the differences between paired observations being statistically significant.

Respiration rates per gram of fresh needles were slightly higher in the polyploid needles as a group, but the differences were not significant. Expressed on a dry-weight basis, the differences in rate were even smaller because of the greater water content of polyploid tissue.

The compensation points for the polyploid seedlings, as shown by the intersect of the curves with the x-axis (Fig. 1), were substantially higher than for the diploid seedlings. This results from the lower photosynthetic rates and slightly higher respiration rates of the poly-

TABLE 1.—RESPIRATION AND PHOTOSYNTHESIS IN DIPLOID AND POLYPLOID SHOOTS GROWING ON THE SAME ROOT SYSTEM, EXPRESSED ON A FRESH WEIGHT BASIS

Seedling	Needle type	Respiration μg. CO_2/min./g.		Net photosynthesis at 2000 f. c. μg. CO_2/min./g.	
		2n	xn	2n	xn
1	Primary	40.2	41.1	37.6	7.3
2	Secondary	16.7	12.7	25.5	8.0

TABLE 2.—AVERAGE CHARACTERISTICS OF DIPLOID AND POLYPLOID SECONDARY NEEDLES. DIFFERENCES BETWEEN MEANS ARE SIGNIFICANT AT THE 1 PERCENT LEVEL, WITH THE EXCEPTION OF THE CHLOROPHYLL RATIO AND NITROGEN CONTENT. PERCENTAGE VALUES ARE EXPRESSED ON AN OVEN-DRY WEIGHT BASIS

Ploidy	Water content (%)	Chlorophyll (%)			Nitrogen (%)	Width (mm.)	Thickness (mm.)	Chloroplast size (μ)
		a	b	$\frac{a}{b}$				
2n	195.6	0.16	0.12	1.33	1.44	1.6	0.9	45.2
xn	247.8	0.23	0.19	1.21	1.57	2.2	1.4	32.5

ploids. Average compensation-point values for primary and secondary needles, as obtained by interpolation, were as follows: in the diploids, 325 and 475 foot candles, and in the polyploids 720 and 1,275 foot candles, respectively.

In addition to the main polyploid shoot, two of the plants had diploid lateral branches that were produced by the root-stock. Determinations made on this type of material are particularly valuable because they afford a comparison between needles of different chromosome numbers under conditions of maximum environmental uniformity. The data obtained on these plants (Table 1) confirmed the results from the separate seedlings, namely, respiration rates did not differ, whereas photosynthetic rates were considerably higher in the diploid needles.

The outline of the polyploid needles in cross-section was more or less irregular and, as indicated in Table 2, they were thicker than the normal needles of diploid seedlings. The increase in thickness was not caused by a larger number of cells but resulted from a general increase in cell size. The polyploids had significantly higher contents of chlorophyll *a* and *b*, per gram of fresh or dry needles, yet the chloroplasts were significantly (0.1 percent) smaller in the polyploids. The ratio of chlorophyll *a* to chlorophyll *b* was the same in diploids and polyploids. The needle water content was significantly higher in the polyploids but the nitrogen content, on a dry weight basis, was the same in both types of needles.

Needles that had been illuminated for several hours were stained with an iodine-potassium iodide solution, and a considerably larger number of starch grains could be seen in the diploid than in the polyploid needles. This observation is in agreement with the greater photosynthetic efficiency of the former.

The lower photosynthetic rates measured in the polyploid slash pines are in agreement with the findings of Larsen (*7*) for various autotetraploids in the genus Solanume and of Andersson (*1*) for tetraploids in the genus Hordeum. On the other hand, Stålfelt (*15*) observed lower photosynthetic rates per unit leaf area and per unit fresh weight in polyploids of the genus Phleum. However, the differences in water content were such that the photosynthetic rates were similar when expressed on a dry weight basis. Johnsson (*6*) found no difference in photosynthesis of half-sibling diploid and triploid *Populus tremula*.

Respiration rates were lower in the polyploids studied by Stålfelt and Larsen. Similarly, Schwanitz (*13*) reported that respiration rates of autotetraploids of the genera Digitalis and Brassica varied between 78 to 87 percent of those of the diploids. The decrease in respiration rate was found to be proportional to the decrease in the ratio of cell surface to cell volume as a result of the larger cells in the polyploids. In relation to the latter point, Brabec (*4*) compared the respiration rates of normal and *gigas* diploid cells in *Lycopersicum pimpinellifolium* Mill. and he also found a lower respiration rate per unit dry weight in the larger cells.

Although the cells of the polyploid slash pine needles were appreciably larger than those of the diploid ones, no significant differences in respiration rates were observed. It seems that respiration in the polyploid cells was not limited by too low a surface-volume ratio.

As was found in this study, polyploid leaves generally have a greater water content than those of diploids. This was found in Hordeum (*5, 1*), in nine genera of herbaceous monocots and dicots studied by Pirschle (*10, 11*), in the Phleum leaves studied by Stålfelt (*15*), and in 28 species and varieties of herbaceus plants investigated by Schwanitz (*12*). Larsen (*7*) however, found little difference in the water content of the diploid and tetraploid Solanum leaves.

There is less agreement in the literature on the effect of polyploidy on chlorophyll content. Larsen (*7*) found slightly less chlorophyll in tetraploids of Solanum, and Pirschle (*10, 11*) reported a lower total chlorophyll content and a greater ratio of chlorophyll *a* to *b* in his polyploid plants. In the large number of plant species studied by Schwanitz (*14*), there were no significant differences in chlorophylls *a* and *b*, xanthophylls, and carotenoids between diploids and tetraploids. The same author quoted a number of references on chlorophyll content, and size and number of chloroplasts, showing that the effect of polyploidy varies greatly from species to species. In the present study, the chlorophyll concentration of the polyploid needles was greater than that of the diploid needles but the individual chloroplasts were smaller. This would imply that their number was greater not only per cell but also per unit volume or weight.

The lower photosynthetic efficiency of the polyploid needles can

therefore not be explained in terms of reduced leaf hydration or chlorophyll content. It is possible that increased leaf thickness results in weaker illumination of at least part of the chloroplasts. It is also conceivable that polyploidy affects in some adverse way one or more of the enzymes involved in the complex photosynthetic process, whereas it apparently does not interfere with the respiratory mechanism.

Although the reduced rate of photosynthesis that is associated with the polyploid seedlings does not account for the total reduction in growth, it nevertheless contributes significantly to it. Previously, the depressed growth rate in polyploid conifers was attributed to abortive root systems. However, the polyploid seedlings used in this study had been grafted on healthy diploid root-stock and had formed good unions. Therefore the reduction in growth was not caused by an inefficient root system but by an unbalance in the shoot. This would indicate that polyploidy in Pinus brings about metabolic disturbances in the synthesis and breakdown of organic substances, along with possible unfavorable auxin relationships. As a result of this, fewer needles are produced bringing about an additional effect in that a smaller leaf area is available to carry out photosynthesis.

The data gathered in the study afford a comparison of the photosynthetic efficiency of primary and secondary needles. As indicated in Figure 1, primary needles of both types were more efficient in weak light and had lower compensation points than secondary needles. These results confirm the findings of Bormann (*3*) on loblolly pine.

Summary

Net photosynthesis and respiration were measured in polyploid slash pine, *Pinus elliottii* Engelm., seedlings that had been obtained by colchicine treatment. The growth rate of polyploid shoots was lower, although they had been grafted on diploid root-stock. Significantly lower rates of photosynthesis were measured in both primary and secondary needles of polyploid as compared to diploid plants, but polyploidy did not significantly affect the rate of respiration. The compensation points for both the primary and secondary needles in the polyploids were also higher. The view is expressed that the lower rates of photosynthesis contribute to the slower growth rate of the polyploids.

The primary needles of both diploid and polyploid plants were more efficient at low light intensities than secondary needles, and had lower compensation points.

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Second Edition of Northwest Forest Soils Manual Available

George Schroeder, chairman of the Northwest Forest Soils Council, has announced that the Council has published a second edition of the manual, "An Introduction to the Forest Soils of the Douglas Fir Region of the Pacific Northwest." The first edition of a thousand copies was exhausted soon after its publication in August of 1957.

This is the only comprehensive treatise on the subject that has been published in the Northwest. Publication of the second edition was made possible through the assistance of the Western Forestry and Conservation Association. Copies may be obtained from the Association at 712 U. S. National Bank Bldg., Portland, Ore., or from the Council's Chairman, George Schroeder, Crown Zellerbach Corporation, Portland, its Secretary, Dr. S. P. Gessel, College of Forestry, University of Washington, Seattle 5, and from SAF Section Chairman Robert Hostetter, BLM, Medford, Ore., or Robert Kischel, Land Dept., Douglas County Court House, Roseburg, Ore.

Cost of the manual is $2.00 for an individual copy. Chapters of the Society of American Foresters, academic institutions, research organizations, and other forestry organizations may secure a discount rate of $1.60 per copy plus shipping charges for orders of 20 or more copies.

Some Effects of Fire on Forest Reproduction in Northeastern Minnesota

Clifford E. Ahlgren[1]

THERE IS LITTLE doubt that forest fire has been a major factor in the natural development of forests in the northern Lake States region for centuries. Soper (*13*) discovered charcoal in different strata of peat in northern Minnesota, indicating the periodic occurrence of fire in that region long before it was settled. Maissurow (*11*) pointed out that the frequent occurance of even-aged, post-fire pine stands indicated that there have been fires in 95 percent of the virgin forests of Wisconsin for at least five centuries. Throughout the literature, there are numerous references relating the existence of superior stands of pine, spruce, and birch to the occurrence of fire (*2,7,9,14*).

Prescribed burning has, however, had limited application in the northern Lake States region, because of the insufficient specific information concerning the immediate and long-range effects of fire on forest regeneration. This paper presents some results of a 6-year study of reproduction of jack pine, black spruce, aspen, birch, and minor species on several burned areas in northeastern Minnesota. It is part of a long term study of the effects of fire on soil and plant succession, other portions of which will be published separately.

Areas Studied

Over 350 plots have been established on about 1,000 acres of burned forest land in the Superior National Forest. Both wild and prescribed burns have been included.

Area I.—Spring wild fire, Heart Lake: Over 800 acres burned in late April 1952. This area had a gently undulating topography and included jack pine plantations, natural jack pine, spruce-fir, aspen, and black spruce timber types as well as land unforested at the time of the burn. The soil ranged in depth from 16 inches to over 5 feet and consisted of loamy sands merging with sand in the lower layers. In some cases the sands were underlain with clay. Although the majority of the area had good drainage, the upper loamy sands were moist, showing a tendency to ball when handled. In the lower depressions supporting sphagnum and black spruce, the water table was nearer the surface and the site was more moist. All litter, much duff, and some humus was consumed by fire. Before the fire, a 2- to 6-inch layer of organic material covered the mineral soil. After the fire, a 1- to 2-inch layer of compacted organic matter mixed with ash remained. This material seemed to be able to absorb and retain moisture and produced ideal seed bed conditions for most tree species. Strong winds caused a fast-moving fire which resulted in spotty scorching of tree crowns in some places. In other places the fire lingered, damaged some cones, and consumed foliage as well as small branches.

Area II.—Summer wild fire, Keeley Creek: Forty acres of jack pine and black spruce burned in mid-July 1955. The area is adjacent to Area I and is similar to it in most respects, although the water table is nearer the surface and the soil is somewhat more moist. A very hot ground fire burned all loose surface litter, much of the duff, and in some places exposed the mineral soil. The intense crown fire completely scorched foliage and consumed small branches. A portion of this area had also burned in 1952. In those parts of the reburned area where all organic matter had been consumed, noticeable erosion was observed. Apparently the structure of the mantle of burned organic matter had been altered or destroyed to such an extent that it was easily removed by water. This was the only place on the study areas where extensive erosion was observed.

Area III.—Summer wild fire, Polly Lake: In mid-July 1952, approximately 60 acres burned. The land was similar in topography and soil to Area I and supported a jack pine forest. It had been logged recently, and green slash was distributed fairly uniformly. All surface litter and most duff was consumed, leaving a compact layer of ash and organic material 2 inches deep.

Area IV.—Prescribed burn, Halfway District: In early May 1956, 40 acres of cutover slash were burned, primarily to reduce the fire hazard and prepare a planting site. Approximately one-third of the area contained one-year-old slash which was fairly uniformly distributed, as was the older slash on the remaining portion. The area had supported a stand of mature jack pine mixed with aspen and birch. The soils were similar to those of Areas I and III, but the topography was more rolling, creating a somewhat drier site. A moderate wind occurred during the burning procedure. The fire removed the smaller slash, leaving larger material only partially burned. Approximately 1 inch of litter was removed, and no duff burned. The mixture of ash and organic material remaining over the mineral soil was 3 to 6 inches deep.

Area V.—Prescribed burn, Isabella District: Eighteen acres of cutover jack pine forest were burned in early May 1956, primarily to reduce fire hazard and prepare a planting site. This area had supported a mature jack pine stand and had been logged the previous summer. The slash was wind-

THE AUTHOR is forester, Quetico-Superior Wilderness Research Center, Ely, Minnesota.

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rowed in piles 3 to 6 feet high. Topography and drainage were similar to that of Area I. The soil was also similar, except that the upper layers of loamy sand extended more deeply. The fire consumed most of the smaller slash in the windrows, leaving the larger material only slightly burned. Under this larger material, about 1 inch of litter was burned, leaving up to 6 inches of unburned organic matter on the ground. The ground fire between the windrows was light, and litter was irregularly and very lightly burned.

Area VI.—Prescribed burn, Plum Lake: Twenty acres were burned in early May 1956, to reduce the fire hazard and prepare a planting site. The area and burn were very similar to those of Area V.

Methods

Two types of plot series were studied. On Area I, a series of ecological plots was established in order to obtain a detailed account of the development of the vegetation. These plots were placed in 14 locations throughout the burned area, sampling the various timber types, soil, and moisture conditions. Two were also placed on comparable, unburned land. Some of the burned area was logged after the plots were established. Three concentric plots, 1/1000-, 1/50-, and 1/10-acre, were placed on each location. From the 1/1000-acre plots, exact counts were obtained of all herbs, shrubs, and trees, together with height and relative percent of space occupied by each species. From the surrounding 1/50-acre plots, data were obtained on the frequency, height, and percent of space occupied by all shrubs and trees less than one inch in diameter. Data on trees 1 inch in diameter and over were obtained from the 1/10-acre plots. On the 1/1000-acre and 1/50-acre plots, counts were made of both early and late summer vegetation. Tree data from the 1/10-acre plots were recorded once each year. At each location, photo points were established from which early and late summer vegetation was photographed.

Within each of the 16 1/10-acre plots, a soil pit was dug to bed rock or to a level of 5 feet. From each pit, soil depth and description, pH determinations at each soil horizon, and profile photographs were obtained. From profiles representative of the variations in horizons found, soil samples were analyzed for available nitrogen, ammonia, calcium, phosphorus, and potassium. Similar information was obtained from soil pits in Areas II, IV, V, and VI. Moisture content and moisture holding capacity determinations were also made, using the methods described by Wilde and Voigt (*16*).

The second type of plot series was established primarily to obtain a larger sample of tree reproduction. These series each consisted of thirty 10 square meter plots placed 10 meters apart. From them, data on tree reproduction, relative frequency of herbs and shrubs, and the space occupied by them were obtained. In Area I, one series was placed in a burned-over 8-year old jack pine plantation which had been replanted with red pine after the burn. A second series was placed in a burned, mature jack pine forest which had not been logged or planted. A third series was placed in a burned, mature jack pine-black spruce forest, also not logged or planted. The fourth series was established in a comparable, unburned, mature stand of jack pine, black spruce, and birch. In Area II, two series of plots were established, one in a burned, mature jack pine-black spruce forest and the other in a burned, mature black spruce-jack pine forest. One series of plots was established on each of the other areas (III, IV, V, and VI).

In order to obtain information on the biological yield capacity of soil from burned areas, soil from the upper 8 inches of the profile in Areas I, II, and IV, was used in a greenhouse experiment in which oats and sunflowers were grown on these and comparable soil from unburned areas. Results of this aspect of the study will be published separately.

In order to obtain information about the amount of seed dispersed after fire, three seed traps were established in Area II immediately following the fire. Each trap consisted of a 1/1000 acre square wooden frame with 5-inch sides and three thicknesses of cotton gauze on the bottom. The traps were placed on logs approximately 6 inches above the ground, and were protected from loss of seed through wind gusts by tar paper shields 5 feet high surrounding the traps, 6 feet from their margins. Seed was gathered at 2-week intervals. Information on basal area and crown size of each tree species was obtained from a 1/10-acre plot surrounding each trap.

Two months after fire, two representative, unburned jack pine adjacent to the burn were felled, limbed, and all cones gathered. On the basis of color, the cones were sorted into two groups: 1 to 5 years old (light to dark bronze) and over 5 years old (ash colored with some lichen growth and scale deterioration). Seed was extracted from these cones and a germination test performed on seed from each age class, planted unstratified in moist soil under greenhouse conditions. A comparable, burned jack pine was also felled, limbed, and cones gathered. Examination revealed that many of the older, ash colored cones had not been opened by the fire, and seed remained in them. The younger cones, however, had shed a large amount of seed. Therefore, the dispersed seed caught in the seed traps was primarily young. These seed were also used in the germination test and compared

TABLE 1.—RESULTS OF GERMINATION TEST OF SEED FROM BURNED AND UNBURNED JACK PINE

Seed age (Years)	1-5		5+	
Source	Unburned	Burned	Unburned	Burned
	Trees			
Number sound seed	157	157	103	103
Number germinated	121	140	26	48
Percent germination	77	89	25	47

TABLE 2.—SUMMARY OF DATA OBTAINED FROM BURNED AND UNBURNED CONTROL SERIES[1]

	Area 1 Series 1	Area 1 Series 2	Area 1 Series 3	Area 1 Series 4	Area 2 Series 1	Area 2 Series 2	Area 3	Area 4	Area 5	Area 6
Age of burn at last observation (Years)	5	5	5	Unburned Control	3	3	6	2	2	2
Type of burn	Ground	Ground & crown	Ground & crown	Control	Ground & crown	Ground & crown	Green slash	Prescribed Old slash	Prescribed Old slash	Prescribed Old slash
Herbs[2] Cover	45%	44%	35%	27%	72%	82%	39%	53%	38%	56%
Height (in.)	9	13	16	6	21	25	11	11	6	8
Dominant herbs	*Calamagrostis canadensis* *Aster macrophyllus* *Cornus canadensis*	*Calamagrostis canadensis* *Pteridium aquilinum* *Aster macrophyllus*	*Rubus idaeus* *Cornus canadensis*	*Cornus canadensis* *Maianthemum canadense*	*Geranium Bicknellii* *Polygonum cilinode* *Calamagrostis canadensis*	*Carex adusta* *Epilobium angustifolium* *Polygonum cilinode*	*Cornus canadensis* *Calamagrostis canadensis* *Rubus idaeus*	*Cornus canadensis* *Rubus idaeus* *Carex adusta*	*Cornus canadensis* *Aster macrophyllus* *Clintonia borealis*	*Aster macrophyllus* *Cornus canadensis* *Rubus pubescens*
Shrubs Cover	44%	46%	49%	43%	4%	1%	38%	27%	40%	30%
Height (In.)	23	22	36	24	9	7	20	18	22	19
Dominant shrubs	*Vaccinium angustifolium* *Corylus cornuta* *Diervilla* *Lonicera*	*Vaccinium angustifolium* *Diervilla* *Lonicera*	*Vaccinium angustifolium* *Ledum groenlandicum*	*Vaccinum angustifolium* *Corylus cornuta*	*Vaccinium angustifolium* *Comptonia peregrina* *Rosa acicularis*	*Comptonia peregrina* *Vaccinium angustifolium* *Diervilla* *Lonicera*	*Vaccinium angustifolium* *Diervilla* *Lonicera* *Alnus crispa*	*Diervilla* *Lonicera* *Alnus crispa* *Vaccinium angustifolium*	*Diervilla* *Lonicera* *Corylus cornuta* *Alnus crispa*	*Diervilla* *Lonicera* *Vaccinium angustifolium* *Corylus cornuta*
JACK PINE										
Original trees per acre	0	330	0	350	280	170	0	0	0	0
Av. diameter (in.)	–	7	–	8	9	8	–	–	–	–
Plots with seedlings	7	26	12	1	29	30	28	10	0	9
Seedlings per acre	100	3,823	451	25	7,257	5,640	1,040	426	–	288
Age (yrs.)	4	4	4	6	3	2&3	5&6	2	–	2
Height (in.)	11	12	8	14	4	3	45	3	–	6
SPRUCE										
Original trees per acre	0	220	200	240	410	540	0	0	0	0
Av. diameter (in.)	–	4	7	4	4	5	–	–	–	–
Plots with seedlings	1	2	21	19	26	27	15	0	2	0
Seedlings per acre	12	25	1,943	764	1,955	3,384	414	–	37 (escapes)	–
Age (yrs.)	3	4	3&4	6+	2&3	1,2&3	4&5	–	13	–
Height (in.)	4	4	5	25	2	2	10	–	18	–
BIRCH										
Original trees per acre	0	20	0	80	0	0	0	0	0	0
Av. diameter (in.)	–	3	–	6	–	–	–	–	–	–
Plots with seedlings	4	3	26	2	24	30	5	18	28	20
Seedlings per acre[3]	263	313	3,484	150	4,311	14,977	125	4,036	21,206	5,815
Age (yrs.)	4	4	4	2&3	2&3	2&3	3&5	2	2	2
Height (in.)	77	84	44	16	8	11	29	36	35	34
ASPEN										
Original trees per acre	0	0	0	20	0	0	0	0	0	0
Av. diameter (in.)	–	–	–	7	–	–	–	–	–	–
Plots with seedlings	7	1	6	3	22	23	21	5	0	3
Seedlings per acre[3]	138	12	75	38	4,298	4,926	1,241	351	–	200
Age (yrs.)	4	4	4	1,3&4	2&3	2&3	5&6	2	–	2
Height (in.)	35	20	28	25	7	6	49	24	–	9
RED PINE										
Original trees per acre	0							0	0	0
Av. diameter (in.)	–							–	–	–
Plots with seedlings	24							16	29	14
Seedlings per acre[4]	1,003							451	576	313
Age (yrs.)	8							5	5	5
Height (in.)	20							7	8	9

[1]Data for each series are based on 30 ten square meter plots.
[2]Herbs and shrubs are listed in order of dominance.
[3]These figures include reproduction by sprouting as well as by seeding.
[4]Planted stock

with seed extracted from older, burned cones (Table 1).

Results and Discussion

Results of both the ecological and reproduction series were very similar. Since the latter give a larger sample of tree reproduction, these are given in Table 2 and below. The ecological plots are referred to only where analysis of data from them revealed pertinent details not obtained by methods used on the other series. A comparison of data from burned and control series (Table 2) made it evident that fire affected the reproduction of all tree species studied. Because of physiological and structural differences among them, however, differences in type of response to fire were found among the species, and each must be considered individually.

Jack pine.—Table 2 shows that under the conditions produced on these burns, germination occurred wherever seed from standing trees was available immediately following fire. On the ecological series, it was found that where there were as few as one mature, dominant tree of 12 inch diameter per 1/10 acre, as many as 15,000 to 20,000 seedlings per acre developed. Side seeding was a factor in Area I, series 1 and 3, the seed being supplied by trees in the path of the prevailing wind up to 300 feet away from the plots. Young seedlings on the unburned control series were very few. Differences in the ratio of seed trees to resultant seedlings, as seen in Table 2 (Area I, series 2 compared with Area II, series 2) may be due to differences in seed bed conditions, and/or to the natural variation in the amount of seed produced and released by different trees. For example, among the three trees felled and examined for part of the germination test, the number of cones per tree ranged from 890 to 5,928.

Seed was also supplied by green slash, as was present in Area III. However, older slash, as present in Areas IV, V, and VI, did not provide adequate seeding. Much of the cone bearing slash was burned, since its dryness contributed to a lingering, destructive fire. Because of the moisture present in green slash, however, fire tended to run through it more rapidly and many of the serotinous cones survived.

While the effect of fire in opening jack pine cones and releasing seed is well known, Table 1 suggests that fire also stimulated seed germination. This may have been due to the action of heat in breaking the partial dormancy of seed frequently found in this species (*15*).

As previously mentioned, wherever a good seed source was combined with good seed bed conditions, reproduction was abundant (Table 2, see Area I, series 2 and Area II, series 1 and 2 and Area III). However, where the area burned contained slash over 6 inches in diameter which did not burn (Areas IV, V, and VI) fire did not effectively reach the ground. Consequently, the layer of organic material remained thick. A thick layer of forest litter and humus rarely provides the steady supply of moisture necessary for good seed bed conditions. Consequently, removal of a sufficient amount of it to allow the very young roots to penetrate to mineral soil is desirable (*3, 6*). In places where a dry organic layer 3 or more inches thick remained, young seedling mortality was high. Seedlings with dead or drying radicles were frequently found in this material.

Most germination occurred the first and second growing seasons following fire (Table 3). On the ecological plots, survival of the original seedlings ranged from 25 percent to 77 percent, averaging 42 percent. Most mortality occurred between the first and second growing seasons. The highest mortality occurred among seed which germinated the first year on summer rather than spring burns. This increased mortality may have been related to the high concentration of ash on the seedbed surface. Reduced germination or young seedling growth on soil with high ash content has also been reported by Fabricius (*4*), Heikinheimo (*6*), and Schmidt (*12*). If seeds germinate in this material before sufficient leaching and dilution by rainfall have taken place, the ash may be present in concentrations toxic to very young seedlings. Apparently under some conditions, high concentrations of ash release amounts of salts into solution in the soil sufficient to cause plasmolysis and death of root hairs and young roots, thus killing or retarding growth of seedlings. It is also possible that the seedlings germinated too late in the summer to develop hardiness and were winter killed. Eyre (*3*) also noted the high mortality of jack pine seedlings on late summer burns and attributed it to lack of winter hardiness.

Growth of seedlings was very slow the first three years. On those series studied for a longer period of time, it was found that growth increased rapidly the fourth and fifth years. Poor seedling survival and growth were associated with heavy growth of certain herbs—for example, *Pteridium aquilinum* (L.) Kuhn, *Calamagrostis canadensis* (Michx.) Nutt., *Carex adusta* Boott, and *Epilobium angustifolium* L. Where such herb growth was found, those jack pines which did survive were thin, light colored, and stunted.

As can be seen in Table 2, most of the shrubs present did not interfere with seedling survival or growth rate. These shrubs constituted from 1 to 49 percent of the cover and varied in height from 7 to 36 inches. However, on the ecological series, in cases where hazel sprouted vigorously the year of the fire and continued to grow rapidly, growth of jack pine germinants was very slow, and survival may be reduced in the future. In cases where a lingering fire destroyed hazel clumps to the root crown or below, resulting in a delayed sprouting, jack pine growth surpassed the brush and competed successfully with it.

Fraser and Farrar (*5*) pointed out that partial shade is necessary for good germination and early growth. This is afforded by the

TABLE 3.—SEQUENCE OF REPRODUCTION BY THE VARIOUS TREE SPECIES FOR SIX YEARS AFTER FIRE[1]

Species:	1	2	3	4	5	6
Jack Pine	1235	761	172	3	..	..
Spruce	57	141	112	1	..	..
Aspen	9	503	207	..	..	..
	(134)	(22)	(4)	(6)	(1)	(8)
Birch	192	1059	423	..	..	..
	(2451)	(210)	(127)	(4)	(1)	(1)
Unburned Control						
Jack Pine	..	..	1	..	..	..
Spruce[2]	2	1	1	1	..	..
Aspen	..	..	..	..	..	..
Birch	..	..	..	..	..	..

[1]Numbers given represent total reproduction found on all plots of the reproduction series, Areas 1-6. Figures in parentheses for aspen and birch represent sprouting.
[2]Spruce reproduction by layering on unburned control.

vigorous herb and shrub cover (Fig. 1) which appeared the first few years following fire. For later growth, direct sunlight is advantageous. The opening created by the fire usually provides this, once the seedlings rise above the herb-shrub layer. Benseud (*1*) found that optimum seedling growth was obtained on soil containing 200 to 250 ppm nitrogen. In the burned areas studied, soil nitrogen concentration was increased after fire to such an extent that it more nearly approached the optimum concentration than did soil from unburned areas (Fig. 2). As can also be noted in Figure 2, other elements are present in higher concentrations on soil from burned land, so that a general fertilizing effect may be present.

Black spruce.—As pointed out by LeBarron (*8*), the cones of black spruce are relatively serotinous and release seed after being subjected to fire. However, under most fire conditions, only cones in tall, mature trees survive and function in reseeding an area. Cones of smaller sized trees are usually destroyed by fire. Apparently, the combination of ground fire and crown fire of the smaller and of the dominant trees produced heat of lethal intensity around the crowns of the smaller trees. Heat was not intense enough around the crowns of the taller trees to destroy the cones. This would explain the differences in reproduction found in Table 2, in Area I, series 2 and Area II, series 1. While the average diameter of the seed trees was 4 inches in both cases, the latter series included several large trees. In even-aged stands, if fire eliminates all but the tallest seed trees, a natural selection of genetic races with the most rapid growth rate may occur.

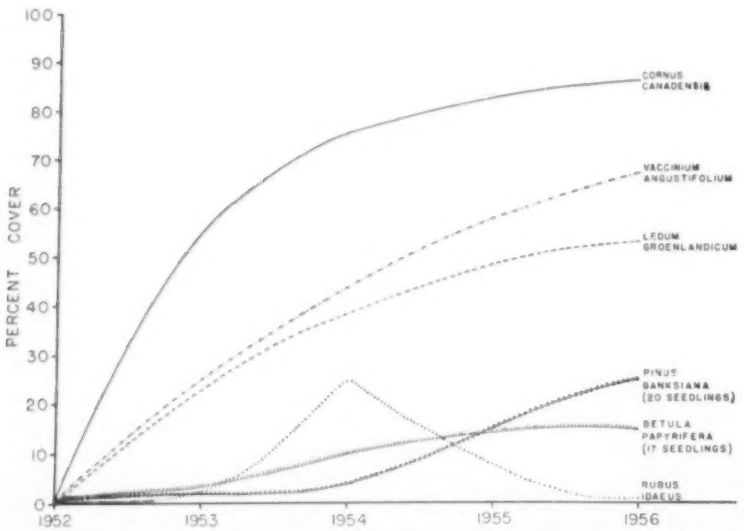

FIG. 1.—Graph showing percent of cover by various species in a sample, 1/1000 acre burned plot, for five years after the fire.

Most successful germination occurred the second and third seasons following fire, one to two years later than that of jack pine (Table 3). This may be because the high concentration of ash on the soil the first year after burning killed young spruce germinants, since Heikinheimo (*6*) reported that spruce seedlings are more easily damaged by ash than are pine seedlings. After a season of leaching and dilution by rainfall, it is possible that the ash concentrations are reduced to a level not toxic to spruce.

Spruce seedling survival varied from 44 to 100 percent, averaging 54 percent. Most mortality occurred the first two growing seasons after germination. Similar to jack pine, spruce seedbed conditions were improved by burning, since the short root is unable to penetrate through deep organic material to mineral soil and the stable moisture conditions found therein. Consequently, removal of organic matter aids seedling survival.

Also similar to jack pine, spruce grew slowly the first three years following fire but increased in height rapidly the fourth and fifth years. On the ecological series, where a dense cover of *Polygonum cilinode* Michx. blanketed the ground the second and third years following fire, seedling mortality was high. No other herb associations correlated with any particular rate of seedling survival or growth. There was also apparently no serious inhibition of growth by the various species of shrubs noted in Table 2.

Trembling aspen.—All reproduction was by sprouting on the ecological series. Despite the presence of living seed trees in or near the area, seedling reproduction was found only on seed beds such as moist mineral soil or compacted sphagnum or other organic material found on low lying sites where

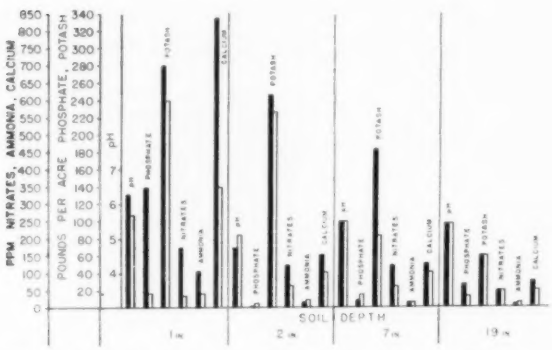

FIG. 2. — Graph showing results of analyses for available nutrients in soil from various depths on a site burned four months previously. The dark bars designate soil from the burned site, the light bars designate soil from a comparable, unburned site.

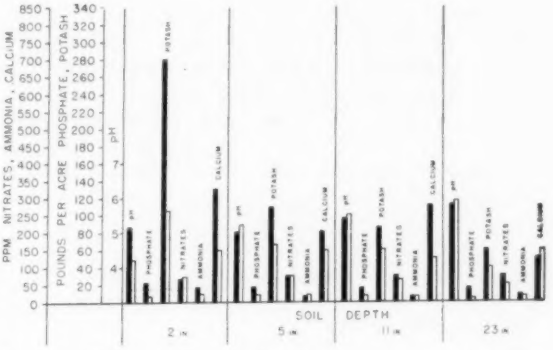

FIG. 3. — Graph showing results of analyses for available nutrients in soil from various depths on a site burned five years previously. The dark bars designate soil from the burned site; the light bars designate soil from comparable, unburned site.

the water table was close to the surface. Most germination occurred the second and third growing seasons after fire (Table 3). In most cases where there was a good nearby source of seed, germination could not be expected the first year since most of the fires occurred after seed dispersal. Consequently, re-seeding after fire had to await a new seed crop.

Abundant sprouting occurred the first season after fire on all burned areas which had supported mature aspen. Survival of sprouts ranged from 25 to 75 percent, averaging 50 percent, and growth was fairly rapid from the beginning. In most plots, the aspen height exceeded that of the other vegetation before the end of the first growing season. Growth of aspen sprouts was slow where they were browsed and in association with hazel, the latter soon dominating such sites. Where no browsing occurred, however, aspen sprouts were above the brush layer from the beginning.

Paper birch.—All birch seedling reproduction was the result of seed blown in from the side, since no birch seed trees were present on the plots. Most germination occurred the second and third years after the fire (Table 3), after a new seed crop was produced on adjoining, unburned areas. The year of the burn, stump sprouts developed readily from the larger, burned birches and were very numerous (Table 3). On low lying sites, however, reproduction by seed was very prominent and undoubtedly more important in the development of future birch stands than sprouting. This agrees with the findings of Lutz (*10*) in his studies of the re-establishment of birch stands in Alaska following fire.

Successful germination occurred only on moist seed beds, such as burned or unburned sphagnum or thin, compacted organic matter over moist mineral soil. Seedling survival on the ecological plots ranged from 0 to 100 percent, averaging 49 percent. On the reproduction plots, however, seedling survival averaged better than 70 percent. Most mortality occurred the second and third years following fire, when the trees were one or two years old. Survival of sprouts ranged from 75 to 100 percent.

Height growth of birch seedlings was usually slow the first three years and began to increase rapidly the fourth year. In cases in which no sharp increase occurred the fourth year, a dense growth of grass (*Calamagrostis canadensis*) or of *Polygnum cilinode* was found on the plot.

Some sparse reproduction was noted on the control series. However, as seen in Table 2, the reproduction was considerably lower on the controls than on the burned series, indicating that burning had some effect on the reproduction of this species.

Miscellaneous species. — Mountain ash sprouts and seedlings appeared the first and second years after fire throughout the burned series. Reproduction was also found on the unburned control series, however. Frequent browsing was noted on this species. Pin cherry reproduction by seed was frequent on the burned series but was very sparse on the unburned areas.

Area I, series 1, was located on a young jack pine plantation which was replanted with red pine following the fire. Five years after planting, survival was 92 percent. The trees had become well established and had overcome the dense grass competition by the second and third seasons after fire. Red pine was also planted in Areas IV, V, and VI. First year survival of these plantings was better than 90 percent except in Area IV, planted during a severe drought period, in which survival was less than 50 percent.

Soil analyses.—The results of chemical analyses of soil samples obtained from a new burn are presented in Figure 2 and compared with similar soil from an adjacent, unburned area. The results of such tests of soil obtained from another area five years after fire are presented in Figure 3. It will be noted that on the newer burn, concentrations of many of the elements present in the upper soil are higher than in soil from the unburned control. On the 5-year-old burn, however, the differences between soil from the unburned control and the burn are not as great.

Under the conditions of these burns, the ash makes a large increase in mineral nutrients available in the upper soil the first year following the burn. These additional nutrients aid in the re-establishment of tree species by: (1) supplying the additional nitrogen necessary for optimum seedling growth, at least for jack pine; (2) stimulating the growth of a lush herbaceous cover which in most cases provides a cool, moist microclimate and conditions of shade necessary for very young conifer seedling growth. While certain herbs characteristic of burned areas may occur in sufficient density to compete successfully with tree growth, most herb cover provides ideal conditions.

Summary and Conclusions

The results of a six-year study of the effect of fire on the reproduction of various native tree species in northeastern Minnesota indicate that:

1. All species studied were capable of reproducing vigorously on burned-over land. However, the time of germination, optimum conditions for growth, and factors influencing reproduction varied among the species.

2. Fire not only aided in the dispersal of jack pine and black spruce seed, but also stimulated germination of jack pine.

3. By reducing the depth of the organic layer so that the seedling roots were able to reach mineral soil more quickly, fire improved seed bed conditions for jack pine and black spruce. These conditions also favored birch and aspen, especially on the more moist sites.

4. Poor reproduction was obtained where the fire did not reduce the organic matter and slash sufficiently.

5. The minerals present in the ash stimulated growth of a lush herbaceous cover. Usually, where not too dense, this provided shade and microclimatic condition favorable to young seedling growth.

6. There were some indications that the ash concentrations present on the soil surface inhibited the germination of black spruce. This inhibition, however, disappeared after one year.

7. Burning did not seriously reduce the concentration of mineral nutrients present in the soil, at least for five years after the fire.

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Correction and Use of Prisms for Point-Sampling

R. F. Bower, N. C. Tuttle, G. L. Heinemann, and D. B. Ostergard

THE CONTRIBUTIONS of Bitterlich, Bruce, Muller, Grosenbaugh, and others have now made the use of variable-radius sample plots in connection with angle gauges, prisms, or special tapes an accepted field method to select sample trees for forest inventory and management purposes.

Point-sampling or variable-radius sample plots facilitate the accumulation, by a one-man crew, of all data obtainable from the conventional plot cruise. Furthermore, it eliminates the necessity for plot radius measurements and the error introduced when plot radius is estimated. The method additionally provides an on-the-spot estimate of basal area per acre and will undoubtedly result in increased use of this important measure of stocking as a forest management tool. The method also avoids the inevitable tendency of conventional plot sampling to disproportionately oversample small trees in relation to their importance in the stand.

Reliable results in point-sampling are dependent on accurate tools and their careful application to the job at hand. This discussion will be limited to the correction and proper use in point-sampling of approximate 3 diopter strength prisms but is equally applicable to prisms of other strengths.

It is desirable for obvious reasons that a prism used for point-sampling have a known accurate and convenient basal area factor such as 10. A diopter strength of 3.03 meets this requirement. Almost all prisms have a built-in or inherent error due to limitations in manufacturing control. The usual inexpensive prisms ($1.35 each) are designated as 3 diopter prisms but have basal area factors ranging from 9.2 to 10.0. This indicates a possible instrument error up to 8 percent. The expensive prisms ($15 each) now available are guaranteed to have a maximum tolerance of 1 minute from the specified angle of incidence of 104.18 minutes required for a 3.03 diopter prism. This tolerance means a basal area factor ranging from 9.8 to 10.2 and a possible instrument error up to 2 percent.

Even greater errors arise from improper use of the prism. Correct use of an accurate prism requires that the prism be held in a horizontal position and at right angles to the line of sight. Any vertical rotation decreases the resultant diopter strength because the difference in glass thickness is thus applied to a longer base, resulting in a smaller angle of incidence. Any horizontal rotation increases the resultant diopter strength because the difference in glass thickness is thus applied to a shorter base, resulting in a larger angle of incidence. Of the two, horizontal rotation is the hardest to detect, when holding a prism with the fingers, and subject to the greatest error. Horizontal rotation can easily change the resultant strength of a 3.0 diopter prism to that of a 5.0 diopter prism.

These basic facts suggest a simple and practical method of slope correction as already described by the U. S. Forest Service in "Forest Survey Field Instructions for Ground Sample Plots in Mississippi." These facts also suggest a simple and practical method of converting any inexpensive approximately 3 diopter prism into an accurate 3.03 diopter instrument which can be used in a manner so as to practically eliminate mechanical error in selection of sample trees around the selected sampling point.

Testing and conversion of a prism to a 3.03 diopter strength and a basal area factor of 10 is accomplished by use of an isosceles triangle laid out on paper with an altitude of 33 inches and a base of 1

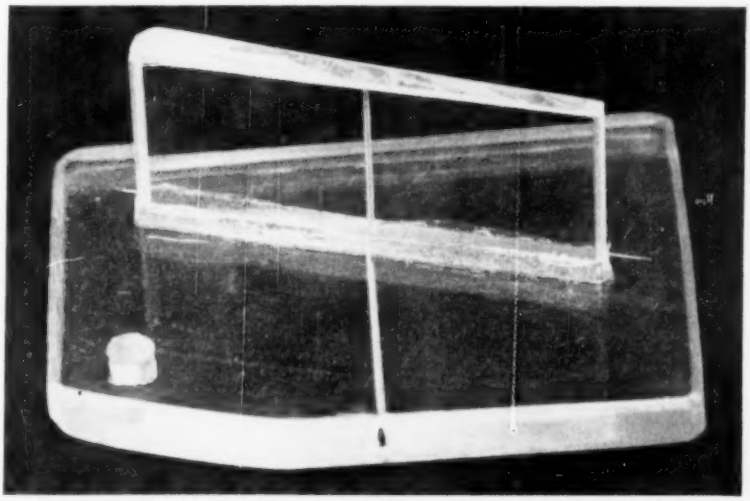

FIG. 1.—Inexpensive 3 diopter wedge prism converted for accurate field use.

THE AUTHORS are foresters of the Hammermill Paper Co., Erie, Pa.

TABLE 1.—COMPARISON OF RESULTS

	Basal area per acre (Sq. ft.)		
Acre no.	100 percent tally	Point-samples	1/10 A. plot
1	72.40	72.70	83.79
2	76.30	82.50	80.61
3	92.23	100.00	95.21
4	94.03	80.00	79.15
5	86.91	80.00	90.45
5 acre average	84.37	83.04	85.84

inch. The 2 equal sides of the triangle subtend the desired angle of of 104.18 minutes. The center of the prism to be tested and corrected is placed at the apex of this angle and at right angles to the altitude of the triangle. If the prism is the right strength (3.03 diopters) it will deflect one side of the angle, as seen through the prism, so as to appear to be perfectly aligned with the other side of the angle as seen on the paper. If the alignment of the image and side of angle does not occur the prism should be rotated horizontally at the apex of the angle until image and object are in perfect alignment. This indicates the degree of rotation required to obtain a resultant diopter strength of 3.03 and a basal area factor of 10 for the prism being tested. This angle of rotation can then be noted and measured with a protractor.

The prism should then be mounted in a clear plastic base (3/16" Lucite) approximately 1½ x 2 inches in size. The approximate angle of rotation as measured can be laid off and the plastic mortised to receive the prism. The prism should then be glued in place.

After mounting the prism, place it over the apex of the isosceles triangle again and rotate the entire instrument until the resultant diopter strength is an exact 3.03 as determined by the deflected image of the sides of the triangle. Hold the instrument in this position and scribe a sighting line on the plastic base so that it is exactly superimposed over the altitude of the triangle. Also, using a right angle triangle, scribe a vertical extension of the sighting line on the face of the prism. Black ink will make these sighting lines more conspicuous. A small hole for a neck cord in one corner of the plastic base completes the instrument.

In use on nearly level ground the instrument is held at eye level and the user sights along the sighting line and on to the target tree. The instrument is held with the top of the prism in a horizontal position. In this position, and with a prism corrected and mounted as described above, determination of trees within the sample area is quite critical.

When slopes over 10 percent are encountered it is necessary to rotate the prism vertically to avoid a significant error. A practical field approach to this can be accomplished by sighting along the upper long edge of the prism to estimated eye level on the target tree. Then turn the wrist so as to rotate the prism 90 degrees, and place the sighting line in line with the target tree, still maintaining the indicated sighting angle. This places the prism in reading position and properly corrected for slope.

A Hammermill Paper Company field party recently completed a cruise on Company property for comparison of point-sampling with plot sampling and with a one hundred percent cruise to determine if inaccurate prisms, corrected to a strength of 3.03 diopters by mounting as previously described, would give reliable results.

Boundary lines for a series of five adjacent one acre squares were surveyed and established in the interior of a wooded area. The diameters (OB) of all trees five inches and over were measured with a diameter tape, tallied and separately recorded for each one acre.

Four points in each acre were systematically located equidistant from each other and from the acre center. Point-sampling techniques were applied from these points using a wedge-prism with an inherent basal area factor of 9.7 corrected by mounting to a basal area factor of 10.

Circular one-tenth acre sample plots were also taped from the same four points in each acre so as to compare plot sampling techniques, previously used, with point-sampling. Diameters of all trees falling within the one-tenth acre sample plots were separately recorded.

Average basal area per acre for each sampling method was calculated for each acre and for the entire five-acre area. The results are shown in Table 1.

The average of the four point-samplings for each acre compared with the 100 percent tally of the comparable acre resulted in basal area variations as large as 15 percent, nevertheless the average basal area per acre for the 20 plots representing the 5-acre sample was only 1.6 percent less than the one hundred percent cruise. The one-tenth acre circular plots gave equally good results on the plus side.

The authors are convinced that statistically sound point-sampling techniques, using inexpensive wedge prisms mounted as described to a resultant strength of 3.03 diopters, will provide reliable inventory information.

A Method for Sampling Eggs of the Black-Headed Budworm[1]

G. T. Silver[2]

BLACK-HEADED BUDWORM, *Acleris variana* (Fern.) outbreaks on western hemlock, *Tsuga heterophylla* (Raf.) Sarg., have been recorded in the coastal areas of British Columbia since about 1927.[3] The latest began about 1950 in the Portland Canal region in northern British Columbia, and by 1952 they had started in the Queen Charlotte Islands. In 1954 the budworm increased to infestation proportions on northern Vancouver Island. As most outbreaks occur in relatively inaccessible areas which in many cases can be surveyed from the ground only once a year, the egg stage was selected as the best means of estimating potential populations. The insect overwinters in this stage. Studies were undertaken to determine the distribution of eggs on the tree crown, the intertree variability, and the selection of an adequate sampling method which would enable the Forest Insect Survey to predict population trends and subsequent damage.

Methods

To determine the inter- and intra-tree variability four dominant or codominant western hemlocks were sampled in 1954. After each tree was felled one branch was selected from each of the four cardinal directions at about the midpoint in the lower, middle, and upper crown levels. The area of each branch was measured. The outer 18 inches were cut from each branch and the area of this portion recorded. A 10-inch tip was then removed from the distal end of the 18-inch sample, and the length of needle-bearing twig measured for both 18- and 10-inch samples. All units were then examined for eggs.

In 1955, 32 localities in the outbreak areas were sampled using only the 18-inch and 10-inch sample units. One sample was taken from each of the three crown levels of each of three dominant or codominant trees in each area. These localities were marked and re-sampled in 1956 and 1957. Damage estimates were also made at each locality to correlate defoliation with egg counts. In 1956 and 1957 the 18- and 10-inch units were retained but two samples were taken from only the top third of the crown of each of three trees. The population was expressed as average number of eggs per sample unit. One hundred and sixty-five localities were sampled in 1956, and these, plus several additional ones, were re-sampled the following year.

Results

The results of the first two years' work showed no differences in the distribution of eggs among the four sides of the crown, nor could it be shown that oviposition was heavier on the exposed sides of the trees. Most of the eggs were found in the top thirds of the crown. As defoliation by the black-headed budworm is always heaviest in the upper crown this section was selected as the sample area. It was also found that the eggs were evenly distributed over the entire branch. A significant difference in egg density could not be demonstrated between the 10-inch, 18-inch, or whole branch samples. Therefore, the 10-inch sample could be expected to give as reliable an estimate as the larger samples. However, defoliation was so heavy in 1956 that it was considered inadvisable to use the smaller unit because the loss of needles on branch tips might result in a changed distribution of eggs. It was therefore decided to retain the larger sample. It was also found that there was a strong correlation between number of eggs per inch of needle-bearing twig and number of eggs for the same sample units, so the time-consuming task of measuring twig length was discarded.

Defoliation estimates made in 1955 and 1956 were compared with egg counts made in the same areas the preceding years. Seven sets of comparisons were available in 1955, and 28 in 1956. Correlation of egg counts in the 165 localities sampled in 1956 with defoliation estimates the following year was impossible due to a collapse in the outbreak in the late larval period of 1957. Damage was classified as light, medium, and heavy, and the egg populations responsible for the corresponding defoliation were averaged. The class limits established were the mid-points between means. The results are shown in Table 1. The number of eggs are given for both sample units.

The percentage of eggs contained on the 10-inch samples as compared with the total number of eggs on the 18-inch sample for the different years was as follows: 1954—31.1 percent, 1955—31.9 percent, 1956—30.6 percent, and in 1957—36.8 percent. Although these are average values, they are close enough to show that the distribution of eggs was fairly constant

THE AUTHOR is stationed at the Forest Biology Laboratory, Victoria, British Columbia.

[1]Contribution No. 487, Forest Biology Division, Science Service, Department of Agriculture, Ottawa, Canada.

[2]The author wishes to thank R. R. Lejeune, Officer-in-Charge, Forest Biology Laboratory, Victoria, B.C., for his helpful suggestions during the planning of the work and his criticism of the paper. Thanks are also due the Forest Biology Rangers of this laboratory for collecting and examining the samples, and to the members of the British Columbia Loggers Association whose assistance made the egg surveys possible.

[3]Prebble, M. L. and K. Graham. The current outbreak of defoliating insects in coast hemlock forests of British Columbia. Part I. Description of outbreak and damage. B. C. Lumberman 29(2): 25. 1945.

TABLE 1.—BLACK-HEADED BUDWORM EGG COUNTS AND CORRESPONDING DAMAGE ESTIMATES. NORTHERN VANCOUVER ISLAND. BRITISH COLUMBIA 1954-56

Description of damage	Classification of damage	Number of points observed	Range of the average number of eggs per sample unit	
			18-inch	10-inch
Total defoliation light, loss of needles on top third of tree crown up to 25%.	light	13	1-26	1-7
Total defoliation up to 40%. Top third of tree crowns heavily defoliated and tops bare as well as considerable tip defoliation on the lateral branches. Up to 70% of the buds may be damaged. General browning or redness visible from the air and vantage points.	medium	13	27-59	8-15
Over 50% of total foliage lost, top third of crowns heavily damaged with complete top stripping. Clearly visible from air by bright red color and bare tips. Over 110 eggs per 18-inch sample may cause complete defoliation of upper half of crown.	heavy	9	60+	16+

throughout the course of the infestation. The greatest variation was in the lighter populations where the percentage of eggs contained on the 10-inch samples was larger than the average. This was most obvious in 1957 when the number of eggs averaged only 0.37 per 18-inch sample. The same ratio was also found in 1956 when in 31 samples averaging three or less eggs, 37.5 percent of the eggs were on the 10-inch samples.

The 10- and 18-inch samples were compared according to the class of expected defoliation into which the different egg samples fell. A summary of the 1956 survey data is given in Table 2.

Nine out of 165, or 5.5 per cent of the 10-inch sample estimates did not agree with their corresponding larger units, and most of these differed by only a small margin. Of the nine discrepancies, seven fell into heavier classes so that on an average there was a slight tendency to over-estimate rather than under-estimate the severity of the outbreak.

The 32 plots established in 1955 and re-sampled the next two years were compared with total average. As shown in Table 3 there was close agreement between the two, indicating that over a large area the smaller number of samples gave a good estimate of the average egg abundance.

The 1956 data were analyzed to determine if the same results could have been obtained by sampling only two trees per area instead of three. The average number of eggs for trees 1 and 2 were compared with the average for all three trees. For the 18-inch units all but 12 of the 165 sample fells in the same infestation class. The largest discrepancy came in the medium class where eight of the 14 disagreed: five were classed as light and three heavy. For the 10-inch samples 15 of the 165 disagreed. Eight out of 15 in the medium class differed; six were classed as light and two heavy. The results were considered unsatisfactory. The extra work involved in cutting the third tree is recommended as it produces a more reliable estimate.

TABLE 2.—COMPARISON OF THE CLASSIFICATION OF 165 INFESTATION LOCALITIES BY THE 18- AND 10-INCH SAMPLE SIZES. NORTHERN VANCOUVER ISLAND. 1956

Infestation class	Number of localities (18-inch samples)	Classes into which comparable 10-inch samples fell		
		Light	Medium	Heavy
Light	148	143	5	–
Medium	14	2	10	2
Heavy	3	–	–	3

Discussion and Conclusions

It should be appreciated that neither egg classes nor damage classes are absolute but are drawn up a result of experience and observation to provide a basis for assessing infestations. The class limits are mid-points between the means. Consequently it must be understood that 26 eggs in one sample and 27 eggs in another will not necessarily produce a marked difference in damage. Also, in the light class one egg per sample will not produce noticeable defoliation, but the number of eggs necessary to produce visible damage is not known. In Alaska, McCambridge arbitrarily selected 0.11 eggs per inch of twig length as the minimum number of eggs required to produce noticeable defoliation.[4] Since his 10-inch samples had an average twig length of 30.4 inches, this value was equivalent to about three eggs per 10-inch sample. He also stated that 0.27 eggs per inch of twig (8 eggs per 10-inch sample unit) would cause general browning of the upper third of the crowns of largest trees, and complete tip defoliation of many lateral branches. A deposit of 1.19 eggs per inch (36 eggs per 10-inch sample unit) produced enough larvae to cause 100 percent defoliation of all needle growth on the upper half of the crown on the tallest and most open-crowned trees. However, larvae from the

[4]McCambridge, W. F. The black-headed budworm survey on the Tongass National Forest, Alaska. U. S. Dept. Agric. Unpublished report. Portland, Ore. 1953.

TABLE 3.—AVERAGE EGG COUNTS FOR 32 PLOTS COMPARED WITH THE TOTAL AVERAGE EGG POPULATION. NORTHERN VANCOUVER ISLAND

Year	Average egg counts	
	In 32 plots	All samples[1]
1955	41.55	–
1956	12.86	12.12
1957	0.39	0.36

[1]Based on 165 samples in 1956, and 171 in 1957.

lower egg counts in the heavy class shown in Table 1 will probably cause heavy defoliation, although damage ranging from several feet of top-kill to tree mortality would be included in the class.

The amount of defoliation already sustained by the trees must be taken into account.[5] In analyzing the 1956 egg survey data a medium egg abundance following heavy defoliation was considered capable of causing heavy defoliation the following year. Other factors which may cause more damage then estimated from egg counts are low egg parasitism, favorable weather conditions resulting in low larval mortality, and the absence of virus disease. Conversely, damage predictions may be high if parasitism is heavy, if virus disease develops among the larvae, or if weather conditions are unfavorable for insect establishment and feeding. It should be recognized that with so many variables involved it is difficult to accurately predict the degree of damage that will actually result from a given number of eggs.

The 10-inch tip sample was retained throughout all the sampling work for the express purpose of testing its reliability. The objective of the sampling should decide the final selection of the sample unit. In this case a method is required which will enable the Forest Insect Survey to estimate the egg population and predict expected damage. The method must be reasonably accurate, but the confidence limits need not be as severe as for basic research work. It is also important that the time required per sample be kept to a minimum to allow greater coverage. Based on 270 samples, the 18-inch samples contained 3.6 times as much needle bearing surface as the 10-inch samples. It was estimated that three 10-inch samples could be examined for eggs in the same or a shorter time than is required to do one larger sample.

Several other criteria must be considered in the selection of a sample unit.[6] In the method used for the black-headed budworm the requirements of random selection are fulfilled. The stability of the sample unit may be questioned on the basis that tip defoliation would affect the 10-inch sample more than the larger unit in cases of heavy defoliation. However the average percentage of eggs contained on the small tip sample remained fairly constant for the different years.

The comparisons made earlier on predictions based on the 10-inch samples showed that the same results as using the 18-inch sample were obtained in 156 out of 165 samples, and there was no indication that the status of the infestation would be under-estimated. The smaller sample unit may therefore be considered sufficiently reliable for survey purposes. It follows that an increase in the number of units sampled would reduce variance and improve the reliability of the method. It is suggested that five, rather than two, 10-inch samples be taken from each tree. Fifteen samples can be collected almost as quickly as six at each sampling point and the time required for examining the foliage for eggs will actually be reduced.

The possibility of developing a sequential sampling method[7] was not pursued for several reasons. More information is required to place more accurate limits on the infestation classes. Another consideration was the size of the timber. No suitable technique has been found to obtain branch samples from large hemlock trees up to 30 inches d.b.h. without felling the trees. Three trees were considered the maximum number which could be cut in each area, particularly when the same areas are sampled each year of the outbreak. Since it is impractical to examine foliage for eggs in the field the entire sample must be collected and taken to a field laboratory. Although a sequential sampling method might reduce the time required to examine foliage in the laboratory, it would not reduce the size of sample required to be taken in the field.

It is concluded that the 10-inch sample unit is reliable for use in general surveys. The numbers of branch samples per tree should be increased from two to five, selected at random from the top third of the crown, and three trees should be sampled at each location. Population is expressed as average number of eggs per 10-inch sample. Caution must be used in predicting probable damage because of the many variables involved.

More information is required to predict accurately the probable damage that can be expected from a given number of eggs, but in the interval the results of this work should provide a useful guide in assessing the severity of black-headed budworm infestations.

[5]Morris, R. F. A sequential sampling technique for spruce budworm egg surveys. Can. J. Zool. 32: 302-313. 1954.

[6]Morris, R. F. The development of sampling techniques for forest insect defoliators, with particular reference to the spruce budworm. Can. J. Zool. 33:225-294. 1955.

[7]Morris, R. F. A sequential sampling technique for spruce budworm egg surveys. Op. cit.

Notes and Observations

A Tool For Planting Cuttings

As a result of expanding interest in the possibilities of hybrid poplars for timber production in the United States, numerous inquiries have been received regarding the tool used to plant the cuttings.

Planting can be done most conveniently with a foot-dibble, as described in 1937.[1] The dibble used at the Northeastern Forest Experiment Station since 1948 is basically similar to the earlier model, but of somewhat better design and construction. Construction and dimensions are shown in Figure 1. This tool, with an 11-inch point, is designed for planting cuttings 12 inches long; for longer cuttings the point should be proportionately longer.

The reducing socket below the foot-bar is most useful in sandy or dry loamy soil to prevent backfilling of the hole when the tool is withdrawn. When the foot-dibble is pushed into the ground with a slight rotary motion to the depth of the foot-bar, the reducing socket firms the soil at the top of the hole, forming a cup-shaped depression.

In planting poplars, the cutting, with buds pointing upward, is pushed into the dibble hole to a depth that leaves the two upper buds above the ground; the soil is then tamped firmly around the cutting with the heel.

ERNST J. SCHREINER
Northeastern Forest Experiment Station, Forest Service, U. S. Dept. Agriculture

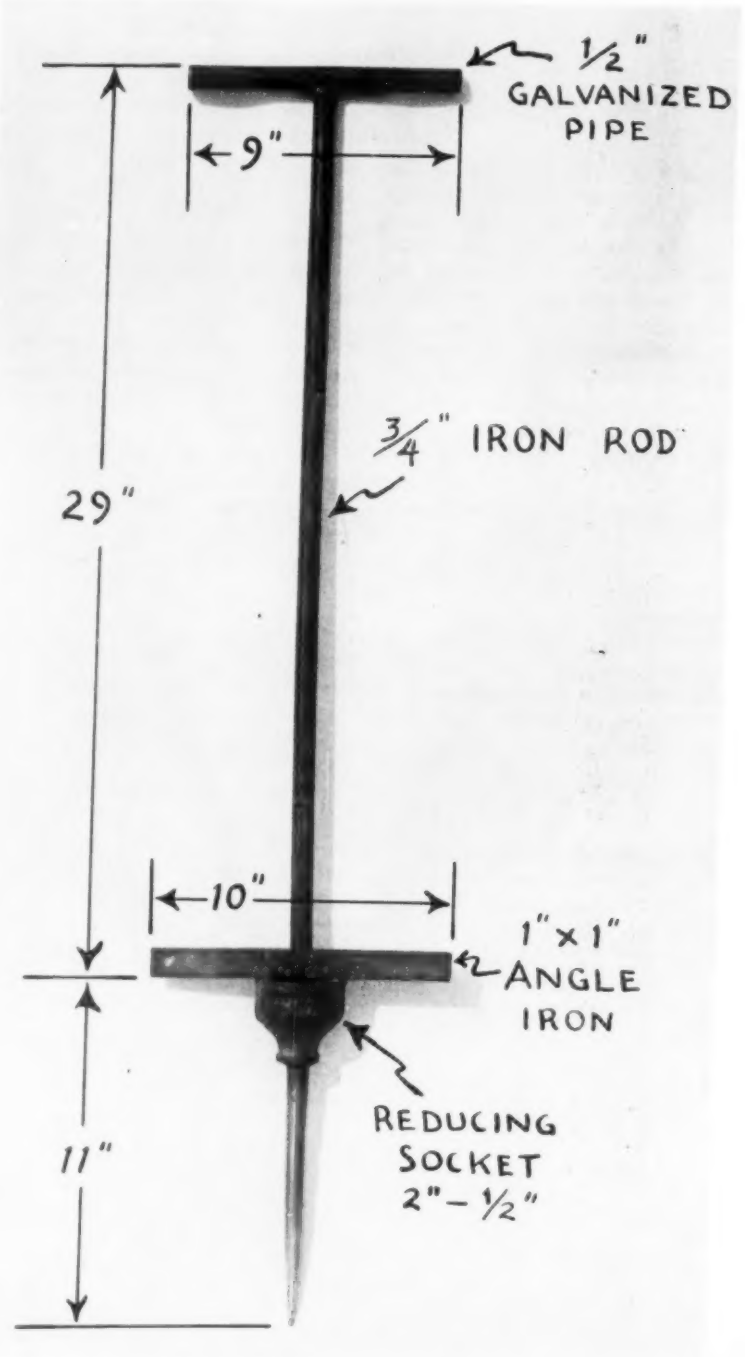

FIG. 1.—The improved foot-dibble used for planting cuttings.

[1]Schreiner, Ernst J. Silvicultural methods for reforestation with hybrid poplars. Paper Industry and Paper World 19: 156-163. 1937.

Tests of Girard Form Class Estimation from Lower Bole Taper

Volume tables based on Girard form class[1] are so commonly used as to have become standard in the South. The mechanical difficulty of measuring Girard form class, however, has led to widespread substitution of ocular estimation or acceptance of species "averages" in lieu of measurement. The error thus introduced into volume computations may frequently exceed the sampling error of the cruise.

Two methods of utilizing lower bole taper to estimate Girard form class were proposed in 1956, both of which gave reasonably precise and unbiased estimates in the original studies. For loblolly and shortleaf pines in Mississippi Horn[2] found that the ratio $\frac{\text{d.i.b. at 7.00 feet}}{\text{d.o.b. at 2.25 feet}}$ approximated the Girard ratio $\frac{\text{d.i.b. at 17 feet}}{\text{d.b.h.o.b.}}$. Although individual trees varied rather widely, samples of 20 trees gave an estimate of the stand average ± two form class numbers.

Working with sweetgum and water oak in the Louisiana Delta and using a method suggested by C. O. Minor,[3] Burns and Adams[4] found that the Girard ratio bore a predictable relationship to the ratio $\frac{\text{d.o.b. at 7.5 feet}}{\text{d.b.h.o.b.}}$. Although, again, individual trees varied widely, samples of 45 trees yielded a stand average ± three-form class numbers. The Minor method requires conversion from the calculated ratio to the estimated form class, unlike the Horn method which gives a direct estimate, but it does permit the use of lower bole taper of bottomland hardwoods, which the Horn method obviously does not because of marked butt taper.

Tests in this study were made in three geographic areas: southwestern Arkansas, northern Louisiana, and southeastern Louisiana. Trees were mechanically selected in forest stands, and none were rejected because of apparently abnormal taper.

As may be seen in Tables 1 and 2 both methods successfully estimated the Girard form class within three form class numbers in every stand but one, and differences over all stands in Arkansas and in northern Louisiana were less than one. It is especially noteworthy that for the two areas mentioned above the Horn estimate should be successful with no modification at all from the measurements established in Mississippi.

The relationship of Girard form class to the Minor ratio turned out to be much more variable. Not only is the relationship different for each of the pines and for each of the hardwoods reported in the original study, but the relationship for shortleaf pine in southwestern Arkansas is different from that in northern Louisiana, as shown in Figure 1.

Although differences between actual Girard form class and that

[1]Mesavage, C. and J. W. Girard. Tables for estimating board foot volume of timber. U. S. Department of Agriculture, Forest Service.

[2]Horn, A. F. 1956. A simplified method for estimating form class of loblolly and shortleaf pine stands in Mississippi. Jour. Forestry 54:185-187.

TABLE 1.—FORM CLASS ESTIMATES OF SHORTLEAF PINE IN SOUTHWESTERN ARKANSAS. ESTIMATES ARE BASED ON 25 TREES IN EACH STAND

Stand	County	Site	Girard	Horn	Minor[1]
1	Pike	Ridge	75	77	75
2	Pike	Slope	76	77	78
3	Pike	Ridge	75	75	77
4	Pike	Old field	81	81	79
5	Pike	Old field	78	79	78
6	Howard	Old field	79	78	80
7	Howard	Ridge	79	80	79
8	Sevier	Ridge	81	80	78
		Average	78.0	78.4	78.0

[1]Girard FC = 1.2 (Minor Ratio) — 35.1

TABLE 2.—FORM CLASS ESTIMATES IN NORTHERN LOUISIANA. ESTIMATES ARE BASED ON 20 TREES IN EACH STAND

Stand	Parish	Site	Girard	Horn	Minor
		LOBLOLLY PINE[1]			
1	Winn	Flat	81	84	82
2	Winn	Slope	83	84	81
3	Grant	Flat	82	84	82
4	Catahoula	Slope	82	83	78
5	Catahoula	Slope	78	81	82
6	LaSalle	Slope	78	78	81
7	LaSalle	Flat	84	84	82
8	Caldwell	Ridge	80	79	80
9	Caldwell	Flat	81	82	81
10	Caldwell	Slope	85	86	82
		Average	81.3	82.5	81.0
		SHORTLEAF PINE[2]			
1	Catahoula	Slope	82	80	83
2	Caldwell	Slope	82	83	84
3	Caldwell	Slope	86	85	84
4	Caldwell	Ridge	85	85	84
5	Caldwell	Ridge	84	83	83
		Average	83.9	83.2	83.5

[1]Girard FC = 21.2 + 0.634 (Minor ratio)
[2]Girard FC = 6.1 + 0.81 (Minor ratio)

[3]Formerly assistant professor, L.S.U. School of Forestry, Dr. Minor is now Chairman, Dept. of Forestry, Arizona State College, Flagstaff, Ariz.

[4]Burns, P. Y. and R. J. Adams. 1956. Girard form class can be estimated from lower bole taper. L.S.U. Forestry Note No. 8. 2 pp.

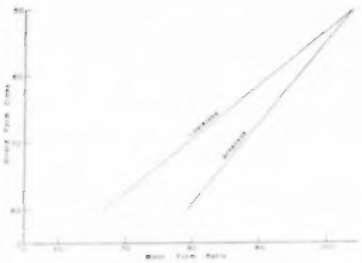

FIG. 1.—Relationship of Girard form class to Minor form ratio, in southwestern Arkansas and in northern Louisiana.

estimated by the Horn method were only slightly greater on the bottomland site in southeastern Louisiana than on the upland sites, Table 3, in eight of the ten stands the actual figure was greater than the estimated one. This certainly suggests that a fairly small but constant bias might well be introduced if the Horn method were adopted with no modification on such sites, a possibility suggested by Horn in his original paper.

Two methods of estimating Girard form class from lower bole taper were tested.

The Minor method of converting from $\frac{\text{d.o.b. at 7.5 feet}}{\text{d.b.h.o.b.}}$ to Girard worked well for both shortleaf pine and loblolly pine, but requires a different set of conversion figures for each species and for each area on which a given species occurs. This somewhat reduces the utility of the method.

The Horn method, Girard F. C. $= \frac{\text{d.i.b. at 7 feet}}{\text{d.o.b. at 2.25 feet}}$, is more easily applied and is directly applicable to both species on the upland sites tested in two states. Although not conclusive, the results obtained indicate that on bottomland sites subject to overflow the Horn method must be modified to allow for the greater lower bole taper.

TABLE 3.—FORM CLASS ESTIMATES OF LOBLOLLY PINE IN SOUTHEASTERN LOUISIANA. MEASUREMENTS WERE MADE IN THE AMITE RIVER BOTTOM, BASED ON 20 TREES IN EACH STAND

Stand	Girard	Horn	Girard-Horn
1	81	78	+3
2	82	79	+2
3	84	80	+4
4	80	78	+2
5	81	77	+4
6	81	78	+3
7	81	78	+3
8	81	82	−1
9	80	80	0
10	81	76	+5
Average	81.2	78.6	+2.6

CHARLES B. BRISCOE[5]
Assistant professor, Louisiana State University, Baton Rouge

[5]The writer is indebted to G. R. Bouchard, J. A. Kromer, T. E. Rogers, and R. G. Whitehead for their assistance in this study.

Litter Weight Not Reduced Following Clearcutting of Poor-Site Oak Stands

Clearcutting hardwood stands is often blamed for loss of litter and exposure of mineral soil which may result in reduced site quality and increased runoff and erosion. Yet clearcutting has not resulted in a reduction in the weight of litter in poor-site upland oak stands in southeastern Ohio. Four years after a pine conversion study was established by clearcutting on the Vinton Furnace Experimental Forest there is as much litter in clearcut areas as in nearby stands of uncut oak forest.

Before clearcutting the 90-year-old, ridgetop mixed oak stand was even-aged and well stocked. Site quality is very poor averaging only site index 45 for black oak. A few native shortleaf and pitch pines present in the stand were taller, straighter, and had less defect than the stunted, slow-growing, defective oaks. Hence the decision to convert to pine.

Soil type is a thin Rarden silty clay loam having an "A" horizon about 3 to 4 inches thick and a heavy-textured "C" horizon (subsoil) averaging 58 to 65 percent clay. The plastic subsoil is prominently mottled and is very slowly permeable to water.

"Litter" is usually divided into three layers: The loose, undecomposed litter ("L" layer); the fermentation layer consisting of partially decomposed litter ("F" layer); and the underlying amorphous humus ("H" layer). On this site, the L layer is about 1 inch thick and the F and H layers are each about ½ inch thick. Humus type is a thin mor[1] or a matted mor.[2] Incorporation of organic matter into the mineral "A" horizon has been slight; thus the "A_1" horizon is absent or, if present, poorly developed.

[1]Hoover, M. D. and H. A. Lunt. A key for the classification of forest humus. Soil Sci. Soc. Amer. Proc. 16:368-370. 1952.
[2]Gysel, L. W. The forest humus layers of Ohio. Soil Sci. 60:197-217. 1945.

The study includes nine ½-acre plots: On six the hardwoods were clearcut during the winter and spring of 1953-1954; the other three were left uncut. A mixture of shortleaf, pitch, and white pines was planted on the clearcut plots in the spring of 1954. Hardwood sprouts were cut and poisoned in half of the planted plots to release the planted pines. On the other planted plots hardwood sprouts were allowed to develop naturally.

The L, F, and H layers in the clearcut plots and in the uncut oak plots were weighed before leaf fall began in September of 1954, 1955, and in 1957. No measurement was made of the small amount of incorporated mineral matter present in the H layer. Areas disturbed by logging, such as roads and skid trails, were avoided.

Oven-dry weights of L, F, and H layers in the uncut oak forest averaged 2,900, 6,100, and 17,700 pounds per acre, respectively. Analysis of variance for sampling in 1954, 1955, and 1957 shows that the weights of organic layers in the uncut forest are not significantly different

from weights of these layers in the clearcut plots. Nor has there been any significant change in the weight of any layer since the plots were clearcut and planted.

It is clear that clearcutting has not resulted in any loss of litter or exposure of bare soil surfaces in this study. Much of the organic matter present on the forest floor before cutting still remains nearly 4 years after cutting. In addition, logging slash and the rapid growth of herbaceous plants, tree seedlings, and hardwood sprouts have furnished much new litter since clearcutting. Adequate future soil protection is assured by the volume of new plant cover now present on the clearcut plots.

WILLARD H. CARMEAN
Soil scientist,
Central States Forest Expt. Sta.,
Athens Forest Research Center,
Forest Service,
U. S. Dept. of Agriculture,
Athens, Ohio

Slash Pine Roots Start Growth Soon After Planting

How soon after pine seedlings are planted do they form new rootlets? This problem was studied at the Chipola Experimental Forest in west Florida, with the aid of "picture windows" (Fig. 1) similar to those used by McDougall.[1] Seedlings were planted next to sloping sheets of glass and soil was removed from the opposite side of the glass to allow periodic observations. On February 3, 1955, three pine seedlings—one slash, one longleaf, and one sand pine — were planted beside each of four picture windows.

Eight days after planting, one slash pine and one longleaf had started root growth, and newly formed mycorrhizae were present on two other slash pines. By February 25, 22 days after planting, roots were growing on all four of the slash pines, but on only two of the longleaf and two of the sand pines. Observations in other years supported these data.

The initiation of root growth of slash pine soon after planting probably accounts in part for the good planting success obtained with this species in the southeastern United States.

FIG. 1.—Root development and mycorrhizae are easy to observe and photograph through "picture windows."

FRANK W. WOODS
Southern Forest Experiment Station, Forest Service,
U. S. Department of Agriculture

[1]McDougall, W. B. 1916. The growth of forest tree roots. Amer. Jour. Bot. 3:384-392.

Points of View

Comments On "Allowable Cut As A New Function Of Growth and Diagnostic Tallies"

The article under the above title by L. R. Grosenbaugh in the JOURNAL OF FORESTRY[1] for October 1958 presents an enthusiastic case for the use of a volume regulation formula involving simple interest growth rates, particularly as opposed to one using compound interest rates. The reader must undoubtedly get the impression that the compound interest formula, designated as the Amortization formula or Meyer's formula, gives incomplete, misleading and inaccurate results with a considerable inconvenience in calculation. He does not appreciate the fact, unless he takes the time to make a thorough analysis, that all the arguments for the new formula and against the old formula constitute merely a tempest in a teapot and that the two formulae do practically the same job and give essentially the same results. Some of the arguments may be true in essence, but inconsequential in effect. Other of the arguments are based on what must be a misunderstanding of the nature and use of Meyer's formula, as will be shown later.

An initial objection will be raised to the statement that compound interest "is favored by the non-biologist," leaving the reader to infer that it is not favored by the biologist and forester. A survey of forestry literature will quickly convince one that the compound interest application in growth problems has a respectable if not a major following among foresters. The use of growth percentages, whether on a simple or compound basis, must be attended with knowledge of the nature of the relation between percentage growth rate and time. In a single forest stand or under a limited forest aggregate, the growth percentage, whether simple or compound, starts off at infinity as soon as a measurable volume is produced. The percentage falls off very rapidly at first and then reduces less and less slowly, but seldom reaching a constant level. In one condition only is the growth percentage constant and that is in the case of the complete forest aggregate that has been developed to the final management goal of full arrangement of age classes with desired level of stocking. Even in this case, the individual elements of the forest behave as described above in regard to growth percentage. The major precaution to be observed in the use of growth percentages in handling a young forest under development for greater future productivity is, therefore, to assure oneself that the rate used applies to the future period under consideration and that this period be not too long. Owing to the nature of the growth percentage curve, a long-term growth percentage can easily have very little meaning and in fact can be seriously misleading, especially in a young forest. One of the chief defects of the proposed "new" or simple interest formula is that an estimate must be made of the long term growth; in fact, this seems to be touted as one of its advantages, when it fact it contributes little if anything to an accurate analysis. It is better and simpler to establish the goal of volume stocking and the time in which this goal should be reached and then prorate back the progress to the specific period of regulation. For example, if a forest aggregate has currently 5,000 board feet per acre and the forester wishes to develop it to an average of 8,000 board feet in 30 years' time, he can allocate 1,000 feet of the development, plus or minus as he deems practicable, to the first 10-year period of control. This is exactly what is done in the application of the compound interest or amortization formula, though not an integral part of the equation itself.

It is possible that the author of the JOURNAL article misunderstands the use of the compound interest formula, if certain statements in the text are taken at face-value. He states the compound interest formula involves only a 1-year projection and that it makes no explicit provision for calculating allowable cut for periods longer than one year. Such is decidedly not the case, in spite of what the mathematical derivations in the text seem to show. The formula gives an estimate of the average annual cut for a forest aggregate that can be obtained over a period of control, such as cutting cycle, during which the forest will be built up (or brought down) to a desired stocking level. At least in essence it does the same job that the new formula is professed to do with so much superiority.

If the use of the compound interest formula is as full of fault as the three pages of arguments imply, then obviously the calculation of allowable cut must be seriously in error and differ radically from that of the simple interest formula. This can be quickly tested by setting up a synthetic example. A 1,000 acre forest now averages 5,000 board feet per acre for a total of 5 million board feet; the plan is to develop it to an average of 8,000 feet per acre in 30 years' time, which prorated back to the first 10-year period of control, indicates a 1,000 foot increase or a total volume 10 years hence of 6 million feet; growth studies have shown that the forest is still in a rapid stage of de-

[1]Grosenbaugh, L. R. Allowable cut as a new function of growth and diagnostic tallies. Jour. Forestry 56: 727-730. 1958.

velopment and that the future ten years promise a compound rate of 6 percent, equivalent to a simple rate of 7.906 percent; to simplify the comparison, ingrowth will be omitted, although its inclusion should introduce no discrepancy in the final comparison.

The comparative calculations proceed as follows:

The simple interest formula in its simplest form:

$$\frac{V_c}{V_a}=\left[\frac{1+nG-\frac{V_n}{V_a}}{nG}\right]\left[\frac{mG}{1+mG}\right]\left[1+\frac{m}{2}G\right]$$

(Where V_a is 5 million feet, V_n is 6 million feet, $n=m=10$ (to avoid the hazard of a long-term growth percentage), G is 7.906 percent, and V_c is the total 10-year cut.)

$$=\frac{1.7906-1.20}{.7906}\times\frac{.7906}{1.7906}\times 1.3953$$

$$=.4602$$

Hence V_c or the *total* allowable cut for 10 years $= 5{,}000\text{M}\times .4602$ or 2,301 M board feet.

The compound interest formula in its simplest form:

$$V_n=V_a(1+g)^n-\frac{V_c}{g}\overline{(1+g)^n-1)}$$

(Where V_a, V_n and n are as above, but g is 6.0 percent, and V_c is the average annual cut for the 10 years.)

$$=5{,}000\text{ M}\times 1.7906-\frac{V_c}{.06}.7906$$

$$=8{,}953\text{ M}-13.177\,V_c$$

Hence V_c of the *average annual* cut is

$= 224.1$ M board feet.

The disagreement between the two results is hardly worth concern. With lower interest rates, the difference would be proportionately smaller, with higher interest rates slightly larger.

The author does finally state toward the end of the discussion that "the particular formula used is not too important." Whether this is said from the realization that a precise result is not needed since it is absolutely essential to revise the estimate of allowable cut at short periodic intervals and hence that past mistakes can be quickly corrected, or whether it comes from the knowledge that the two kinds of formula give almost the same result in spite of all the arguments, is not clear, though the first is inferred later on.

Should the reader still be hesitant to use compound interest because he is informed that the calculation is difficult since he will have to use a compound interest table, let him be consoled by the fact that such a table is not necessary nor even desirable. It is far simpler and more accurate to use a logarithm table to reduce the estimated 10-year growth to a single rate or to blowup a single year rate to a 10-year accumulation.

The use of permanent sample plots to obtain reliable growth information is a desirable feature of the proposal, providing of course that blind dependence be not placed on the percentage growth rate of the past period being directly applicable to the future period. As mentioned previously this does not accord to the nature of the growth percentage relation to passage of time and can lead to serious discrepancy. Measurements of past growth, no matter how accurately they are obtained, must be used with a large measure of discretion and with a knowledge of what has happened in the past and what may happen in the future.

The final remark of these comments is addressed to those who have used the compound interest formula to assure them that all is not as bad as it sounds. Abandoning the old for the new will make little if any change. In any event the two formaulae, under discussion apply only to a limited variety of problems. They are strictly volume control formulae and assume that the estimated growth percentage remains relatively unchanged through variations in method of cutting and through a moderate variation in intensity of cut. They both deal best with somewhat immature stands and are not suited to forest aggregates containing a large portion of virgin timber. They are both probably more suitable for all-aged management than for even-aged management, although this is questionable.

WALTER H. MEYER
School of Forestry,
Yale University

Book Reviews

Forest Seeding and Planting Techniques and Equipment

By G. F. Weetman. Reprint of Tech. Rept. No. 74. Pulp and Paper Research Inst. of Canada. 130 pp. Illus. Processed. Montreal. 1958. No price indicated.

It is a pleasure to review publications such as this excellent one issued by the Pulp and Paper Institute of Canada. *Forest Seeding and Planting Techniques and Equipment* is chock-full of up-to-date and very useful information, including a bibliography of 145 references to material the author deems pertinent to the subject. It will be welcomed by foresters and others both in Canada and the adjacent United States. One cannot but wonder why no reference is found to any of the Forest Planting Notes of which 32 have been issued by the United States Forest Service; perhaps because none of this series had come to the author's attention.

Very appropriately, major emphasis is placed upon the treatment of reforestation areas prior to seeding or planting and the choice of species and sites—in other words, prescription reforestation, including the development of higher quality planting stock that will result in higher survival and better growth on particular sites. Mechanical planting aptly comes in for its share of consideration, especially under present labor conditions.

The author cautions that only in very exceptional cases can plantations be left without follow-up care between establishment and their harvest. They will usually require as much, and sometimes even more, care than naturally developed stands. In either case adequate protection must be provided. Release from competing herbaceous and shrubby vegetation and from taller undesirable trees is beneficial and often necessary for survival and optimum growth. The use of fertilizers in plantations on relatively poor sites is justly emphasized and will doubtless receive greater attention in future researches.

In the stimulating discussion of thinnings in plantations the reviewer is inclined to the view that the author may be somewhat too conservative in his statement that row thinning in which every sixth row is removed "is not necessarily always the best silviculture." Experience in thinning loblolly pine plantations in the Duke Forest in which every eighth row is removed in the first thinning and the intervening rows subjected to conventional thinning (the reviewer prefers the crown thinning method) is considered not only good silviculture but also good management and sound economics.

In a review of moderate length it is impossible to bring out all the good points in a publication such as this one. If it creates interest in the author's very timely contribution its major objective will have been largely accomplished.

C. F. Korstian
Duke University

Of Men and Marshes

By Paul L. Errington. 150 pp. Illus. The Macmillan Company, New York. 1957. $4.50.

To wildlifers who know Paul L. Errington for his scientific writing *Of Men and Marshes* may come as somewhat of a surprise for he has in previous writings omitted the philosophical and the aesthetic; he has tried very successfully to be the objective and unbiased scientist. This work gives an insight into the motivation of the man who has done many investigations in the field of wildlife management. Here we get a chance to estimate some of the hidden pleasures which caused him to carry on these scientific efforts.

Dr. Errington is the professor of Vertebrate Ecology at Iowa State College, Ames. He was born in South Dakota and took his undergraduate work at South Dakota State College. He did graduate studies with Aldo Leopold at the University of Wisconsin. His work on bobwhites, ring-neck pheasants, water fowl, mink, muskrats, and food habits of avian and mammalian predators has been outstanding. His paper on influence of predation on animal populations is cited in almost every population study report.

In a sense *Of Men and Marshes* is related to those population studies. Its basis is the changes in the number and composition of the animal and plant life on midwest wetlands. As the work follows these changes through the seasons, it contrasts wetlands in various parts of the country and links marshes to other geographical phenomena as they relate to the isolation of life forms. It expounds an interesting philosophy on the soothing psychological effect of marshes on men. The author stresses the value of retaining marshes for their own sake. The importance of hunting and fishing as a use for marshland is rather thoroughly covered.

The book is one which will provoke discussion. It should be "must" reading for those who have interest in, or have to do with, the problem of land use. It is easy reading and treats the subject of marshes in a light but sound manner. In parts the author has written a sort of travel guide for those who would visit some of the better known and often-referred-to marshlands.

One section treats the subject of safety and comfort in marshes and, of course, cites the old wives' tale regarding the pestilential nature of standing water; the old concept being that marsh water is foul and

full of pathogenic micro-organisms because it may be stagnant, overlying mud, or choked with vegetation. Human beings are not necessarily in danger of "catching something" from the marsh water. Even the mosquito is not necessarily a great threat to human life. In the Northern Plains, which Dr. Errington is discussing, the lawns and front yards may be as substantial producers of mosquitoes as are the marshes.

A strong plea is made for retaining marshes, or at least some of them, for outdoor laboratories. Many kinds of these laboratory marshes are needed, particularly those in which man is not a disturbing element. It is here that the forces that operate on all populations can have a point of reference.

The book points out that the author, as well as other ecologists, sees the parallel between human and sub-human responses to crises.

If man is to be aware of the laws of life which may catch up with him, he must know how these laws work.

RICHARD M. MAY
Willimantic, Connecticut

Tropical Silviculture

By I. T. Haig, M. A. Huberman, and U Aung Din. Vol. I, 190 pp.; Vol. II, 415 pp.; Vol. III, 101 pp. Illus. Food and Agriculture Organization of the United Nations, Rome, Italy. 1958. (FAO Forestry and Forest Products Studies No. 13). Vol. I, $2; Vol. II, $4; Vol. III, $1.

Among the most neglected of man's renewable resources are the world's tropical forests.

And this in spite of the fact that tropical forests cover almost half the world's forest area, that their rate of growth, compared with temperate species, makes them the greatest wood factories on earth. They are the most bewildering and, from the standpoint of human values, possibly the most rewarding of all tree associations.

Yet the values and varied uses of that great complex of species are still incompletely known. Chemical possibilities have barely been scratched; silvicultural requirements remain in large part enigmas, subject of controversies wherein speculation is more abundant than proven facts. Even for teak, sal, or mahogany, those forest giants that have been serving man for centuries—even for these no completely satisfactory silvicultural systems have yet been established.

Many factors have made for this lack of information. The overwhelming number of species, inaccessibility, dubious transportation, absence of dependable markets, backward local industries—all these have militated not only against the rational use of tropical forests, but against any pressing incentive to seek out a body of dependable facts on which forest management must be based.

The need for more precise knowledge has long been recognized. Eleven years ago one of FAO's early committees—the Committee on Unexploited Forests—meeting in Geneva, strongly recommended a beginning of such studies. Since then, at international congresses and regional meetings, the need has been repeatedly stressed, both for adding to existing knowledge and for making more readily available whatever knowledge had been already won.

One of the major difficulties has been the tropical forester's uncertainty in answering the question, "After cutting, what shall I do to secure successful natural regeneration of species of proven value?"

The first attempt to answer that question on a world basis now appears in the three volumes of *Tropical Silviculture*, published by the Food and Agriculture Organization of the United Nations. This is the work of I. T. Haig, M. B. Huberman, and U Aung Din. All are members of the International Society of Tropical Foresters, and the first two are members of our own Society.

Tropical Silviculture is based on a series of papers presented at the Tropical Section of the Fourth World Forestry Congress, held in 1954. Volumes II and III are devoted to those papers, but to them is added a broad survey of other pertinent literature.

The publication is primarily a summary and evaluation, not a handbook of detailed practices. It covers only the regeneration of natural forests. Plantations and planting are not dealt with, except as the treatment of some types involves brief descriptions of planting, where artificial regeneration is employed, and here the emphasis is on silvicultural method, not on planting techniques.

Within these very definite limitations which the authors have realistically set for themselves, *Tropical Silviculture* represents a long-awaited and much-needed milestone, a structure to be built upon, a basis about which to center added facts as they may come to light.

Summing up, as it does, the information now available on the natural regeneration of tropical forests, the book is directed to the very practical end of assisting forest technicians and administrators to plan the best silvicultural practices for the forests of the Tropic Zone. It will have special usefulness to foresters working in the American tropics, for it is to be published later in Spanish.

The bibliography alone would amply justify this publication. But in addition, Volumes II and III perpetuate the best of the tropical papers presented at the Fourth World Forestry Congress, and so serve the added purpose of gathering together what, four years ago, represented the extent of knowledge on the important aspects of tropical forestry. It can be hoped that the Fifth World Forestry Congress, to be held in 1960, may afford an opportunity for garnering the further harvests of the intervening years.

Tropical Silviculture is to be reviewed in *Forest Science* by Dr. Frank Wadsworth, who is much more competent than this reviewer to evaluate the publication's technical aspects. This present note

aspires only to celebrate an important addition to forestry literature and to congratulate FAO and the authors on taking the first step along a difficult, too-little-traveled road.

TOM GILL
Charles Lathrop Pack Forestry Foundation

Problems in Wood Chemistry

FAO Technical Panel on Wood Chemistry. 136 pp. Illus. Interscience Publishers, Inc., New York 1, N. Y. 1957. $6.75

The Seventh Session of the Technical Panel on Wood Chemistry of the Food and Agriculture Organization of the United Nations was held April 8-13, 1956, in cooperation with the Institute for Fibres and Forest Products, Israeli Ministry of Agriculture, in Jerusalem and Haifa. The lectures and discussions are published in this small volume. The lectures were given by men who are well-known authorities in their fields.

Herman Mark, director of the Polymer Research Institute, Polytechnic Institute of Brooklyn, presents a comprehensive report on the physical and chemical fundamentals of radiation chemistry and a few important applications in polymer chemistry in anticipation of a great deal of research activity in the radiation chemistry of wood and wood products.

In the second chapter, Professor Giertz, Department of Wood Chemistry, Technical University of Norway, Trondheim, presents a rather complete discussion of the chemistry, morphology, and mechanical properties of the compound middle lamella of wood (the compound middle lamella comprises the intercellular substance plus the adjacent primary walls of the contiguous woody cells). Unfortunately, the pages of coated paper used for the illustrations in this chapter are poorly bound and detach easily even with careful handling.

A short review of some of the available knowledge on the middle lamella of the bast fibers and its influence on their properties, with special reference to jute and flax, is presented by Dr. M. Lewin, director of the Israeli Institute for Fibres and Forest Products Research.

Professor Freudenberg of the University of Heidelberg discusses whether lignin-carbohydrate bonds exist in coniferous wood and concludes that a definite answer cannot be given now.

Dr. Edwin Jahn of the State University College of Forestry at Syracuse, New York, discusses the expansion of wood utilization through the use of resins. The use of resins in the wood industry has grown very rapidly with the development of the synthetic resins. Resins permit greater and better use of wood raw material, including waste and low-grade wood. They also improve the strength and appearance of the product, diminish dimensional change and thereby place wood in a better competitive position in relation to other substances.

Dr. Mark, in his second lecture, reviews the principles of adhesive bonding—theoretical limits of adhesive strength, how far we need to go to approach this limit, and what new materials and methods of application could lead us to consistently better results.

Emil Ott and C. A. Heiberger, Chemical Divisions, Food Machinery and Chemical Corporation, New York, briefly consider new developments in synthetic resins for adhesives, especially polyvinyl acetate, epoxy resins, and modifiers for phenol- and amine-aldehyde resins. Their article is concluded with an annotated bibliography of 120 abstracts from the recent literature.

During their stay in Israel the members of the Technical Panel on Wood Chemistry visited various institutions and plantations. Brief descriptions of these organizations and their activities bring to a conclusion this interesting and useful little technical book. It is regretable that this book contains an inordinate number of typographical errors. Fortunately, most of these errors have been corrected in a sheet of corrigenda accompanying the book.

IRVING H. ISENBERG
The Institute of Paper Chemistry

Publications of Interest

Forestry in England is a 16 page bulletin describing the history and present extent and nature of forests and forestry in England. Without ignoring forestry on private estates, emphasis is given to the work of the Forestry Commission, created under the Forestry Act of 1919. Published by The Forestry Commission, 25 Savile Row, London W.1, England. No price indicated.

* * *

The Forest Genetics Research Foundation, Berkeley, Calif., has published a report entitled *Forest Genetics Research in the Rocky Mountain and Pacific Coast States and British Columbia* which gives the results of a recent survey of this work. The report briefly describes each of the 156 research projects now being conducted by 22 agencies in the region and summarizes the information to show which taxonomic groups of commercially important forest trees are being studied and the nature of the investigations now in progress. The foundation will use the information as a basis for implementing its policy of supporting the kinds of research most needed, thereby helping to develop a well coordinated research effort. The report is also published to make the information available to institutions and individuals similarly interested in a regional research program that will most effectively provide genetic improvement to the western forest resource as a whole.

Correction

The Current Literature citation for *Elementary Statistics for Foresters*, by A. J. Nash, published by Lucas Bros., Columbia, Mo., appearing in the January issue of the JOURNAL, incorrectly listed the price at $2.00. The correct price is $2.90.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University College of Forestry at Syracuse University*

Range Management Section Compiled by NELLIE G. LARSON, *Library, U. S. Department of Agriculture*

General

Forestry in the Federal Republic of Germany. 55 pp. Illus. Federal Ministry for Food, Agric. and Forests, Bonn, Germany. 1958.

Forestry of Japan 1957. 216 pp. Map. Forestry Agency Japan Ministry of Agric. & Forestry, Tokyo. 1957.

Green Power; the Story of Public Law 273. By James Stevens. 95 pp. Illus. Superior Publ. Co., Seattle, Wash. 1958. $3.

The Physiology of Forest Trees. By K. V. Thimann. 678 pp. Illus. Ronald Press, New York. 1958. $12.

Timber, Its Development and Distribution; a Historical Survey. By Bryan Latham. 303 pp. Illus. George G. Harrap & Co., Ltd., London. 1957. $3.50.

Your Guide to Swedish Forestry. 31 pp. Illus. The Swedish Forestry Ass'n., Stockholm. 1958.

Forest Economics

Development of the Veneer and Plywood Industry in California. By R. H. May. 26 pp. California Forest & Range Expt. Sta., Berkeley. 1958. For. Survey Release No. 34.

Forest Genetics

Forest Genetics Research in the Rocky Mountain and Pacific Coast States and British Columbia; Report of a Survey by the Forest Genetics Research Foundation, San Francisco 4, Calif. 1958.

Forest Influences

The Influence of Smelter Fumes on the Growth of White Pine in the Sudbury Region. By S. N. Linzon. 45 pp. Illus. Ontario Dept. of Lands & Forests and Dept. of Mines, Toronto. 1958.

Seasonal Development and Yield of Native Plants on the Upper Snake River and Their Relation to Certain Climatic Factors. By J. P. Blaisdell. 68 pp. Illus. U. S. Dept. of Agric., Washington 25, D. C. 1958. Tech. Bul. No. 1190.

Forest Management

The Management of Natural Tropical High-Forest with Special Reference to Uganda. By H. C. Dawkins. 155 pp. Imperial Forestry Institute, Univ. of Oxford, Oxford, England. 1958. Inst. Paper No. 34. 25s.

Forest Resources

Continuous Forest Inventory of British Columbia. 200 pp. Illus. and tables. Minister of Finance Public Information & Edue. Div. British Columbia Forest Serv., Victoria. 1958. $7.35 (Canadian).

Japanese Oak Lumber for 1958. 56 pp. Illus. The Hokkaido Hardwood Lumber Exporters' Ass'n., Otaru, Japan. 1958.

World Timber Trends and Prospects. By Torsten Streyffert. 350 pp. Illus. Publ. in Europe, available from Texstar Co., 200 W. 34th St., New York 1. Dec. 1958. $9.75.

Land Use

Vegetation and Topographic Situation as Indicators of Forest Land Classes in Air-Photo Interpretation of the Alaska Interior. By H. J. Lutz and A. P. Caporaso. 31 pp. Illus. Alaska Forest Research Center. 1958. Sta. Paper No. 10.

Pathology

Elm Disease . . . 7 pp. Illus. Great Britain Forestry Commission, London. 1958. Forestry Commission Leaflet No. 19 (revised) 9d.

The Occurrence of the Indian Paint Fungus, Echinodontium tinctorium E. & E. in British Columbia. By G. P. Thomas. 30 pp. Illus. Canada Dept. of Agric., Ottawa. 1958. Publication No. 1041.

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Ecological Effects of Fire on North Swedish Forests. By Evald Uggla. 18 pp. Almqvist & Wiksells, Uppsala. 1958.

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Range Management

Big Sagebrush Control. By H. P. Alley, and D. W. Bohmont. 6 pp. Illus. Wyoming Agric. Expt. Sta., Laramie. 1958. Bul. No. 354.

Chemical Composition of Certain Native Forage Plants. By J. W. Hamilton. 44 pp. Illus. Wyoming Agric. Expt. Sta., Laramie. 1958. Bul. No. 356.

Dual-Purpose Pastures for the Short-grass Plains. By Frank Rauzi, Robert Lang, and O. K. Barnes. 16 pp. Illus. Wyoming Agric. Expt. Sta., Laramie. 1958. Bul. No. 359.

Economics of Adjusting to Drought on Eastern Oregon Cattle Ranches. By J. R. Gray and C. V. Plath. Oregon Agric. Expt. Sta., Corvallis. 44 pp. Mimeo. 1957. Misc. Paper No. 48.

Minor Mineral Elements and Other Nutrients on Forest Ranges in Central Louisiana. By D. A. Duncan and E. A. Epps, Jr. 19 pp. Louisiana Agric. Expt. Sta., Baton Rouge. 1958. Bul. No. 516.

New Methods to Improve Shortgrass Range. By C. F. Becker, R. L. Lang, and Frank Rauzi. 12 pp. Illus. Wyoming Agric. Expt. Sta., Laramie. 1957. Bul. No. 353.

Role of Native Forage Plants in Cattle and Sheep Production. By J. W. Hamilton. 8 pp. Wyoming Agric. Expt. Sta., Laramie. 1958. Cir. No. 66.

Rotational Versus Continuous Grazing of Cattle, Sheep, and Horses. By R. E. Hunt, C. M. Kincaid, and G. W. Litton. Virginia Agric. Expt. Sta., Blacksburg. 1958. Bul. No. 495.

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How to Prepare Gulfcoast Sandhills for Planting Pines. By F. W. Woods, J. T. Cassady, and Harry Rossell. 11 pp. Illus. Southern Forest Expt. Sta., New Orleans, La. 1958. Occasional Paper No. 161.

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Silvical Characteristics of Plains Cottonwood. By R. A. Read. 18 pp. Illus. Rocky Mt. Forest and Range Expt. Sta., Fort Collins, Colo. 1958. Sta. Paper No. 33.

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Effect of Gum Veins and Pockets on the Bending Properties of Jarrah Scantlings. By N. H. Kloot and K. B. Schuster. 8 pp. Australia Commonwealth Sci. & Indus. Res. Org., Melbourne. 1958. Div. of Forest Prod. Technological Paper No. 2.

Some Properties of California White Oak and Oregon White Oak. By B. H. Paul, A. W. Dohr and J. T. Drow. 8 pp. Tables. U. S. Forest Products Laboratory, Madison, Wis. 1958. Rept. No. 2135.

The Sorption of Water Vapour by the Constituents of Wood: Determination of Sorption Isotherms. By G. N. Christensen and K. E. Kelsey. pp. 265-82. Australia Commonwealth Sci. & Indus. Res. Org., Melbourne. 1958. Div. of Forest Prod. Reprint No. 349.

Society Affairs

Council's Column

Profile of a 1975-2000 Forester?

Everyone active in forestry today is happily aware of the widening opportunity to practice forestry at a profit.

A few decades ago foresters were putting much emphasis on "minimum practices" that presumably would perpetuate a timber type and perhaps provide for at least a rather modest level of future productivity.

Until just a few years ago, this was about the most forestry that our profession could sell to the majority of timberland owners. Many of them just couldn't afford to buy more. Some of us who owned timberlands will remember that we couldn't afford the kind of practices we wished were possible on our own lands, either. This situation still prevails over extensive areas today, but the economic climate for forestry is definitely ameliorating.

Nowadays more and more forest owners are looking for every possible new measure or technique that will increase the yields from their lands. This is a stimulating attitude for a forester. It solves some of his toughest old problems, but it brings him a lot more new ones, too. One of them is to decide what *kind* of a forester to be.

Time was, until recently, when a forester was a forester. Now, fewer timberland problems are being solved by foresters working singly; more and more are being solved by task forces of highly skilled specialists. Changing economics has made many complicated forestry relationships a matter of dollars-and-cents concern. The dirt forester of yesterday ignored many of these factors, because by no stretch of his imagination could he regard them as having practical significance. Usually he was safe in taking this course, too.

But now, for example, relationships such as the effect of seed source and cutting practices on the specific gravity of wood, or the effect of cultural measures on wildlife habitat and watershed conditions, have suddenly become very important to owners determined to realize the maximum multiple benefits from their forest lands.

The demand for skills in such specialties as forest entomology, pathology, genetics, soils, hydrology, wildlife management, wood technology, chemistry, physiology, wood utilization, engineering, physics, meteorology, creative writing, and mathematics was never higher and is still headed upward.

The impacts of this trend on the profession, the Society and its members merit careful analysis.

Is forestry becoming so complex that almost everyone should specialize in some single part of it? Such a trend appears to be well advanced in medicine, law, and engineering. To what extent will the jack-of-all-trades forester be in demand in the years ahead? What will be his best prospects for making a truly significant contribution?

Are there likely to be key opportunities for forester-diagnosticians who are especially skilled in determining what other types of specialists to consult? Presumably such professionals would specialize in the new field of diagnostic techniques, but would rely on other specialists to help write and perhaps help administer the prescriptions.

What is the professional outlook for

Officers and Council
1958-1959

GEORGE A. GARRATT, *President*
School of Forestry
Yale University
New Haven 11, Conn.

B. E. ALLEN
Union Bag-Camp Paper Corporation
P. O. Box 570
Savannah, Ga.

PHILIP A. BRIEGLEB
Southern Forest Experiment Station
704 Lowich Building
2026 St. Charles Avenue
New Orleans 13, La.

DONALD E. CLARK
U. S. Forest Service
Federal Center, Building 85
Denver 7, Colo.

HENRY J. MALSBERGER, *Vice President*
Southern Pulpwood Conservation Association
900 Peachtree Street, N. E.
Atlanta 9, Ga.

CHARLES A. CONNAUGHTON
U. S. Forest Service
630 Sansome Street
San Francisco 11, Calif.

KENNETH P. DAVIS
School of Natural Resources
University of Michigan
Ann Arbor, Mich.

MAURICE K. GODDARD
Department of Forests and Waters
Harrisburg, Pa.

HENRY CLEPPER, *Executive Secretary*
Mills Building, 17th Street at Pennsylvania Avenue, N. W.
Washington 6, D. C.

WILLIAM D. HAGENSTEIN
Industrial Forestry Association
1410 S. W. Morrison Street
Portland 5, Ore.

J. HERBERT STONE
U. S. Forest Service
729 N. E. Oregon Street
Portland 8, Ore.

HENRY J. VAUX
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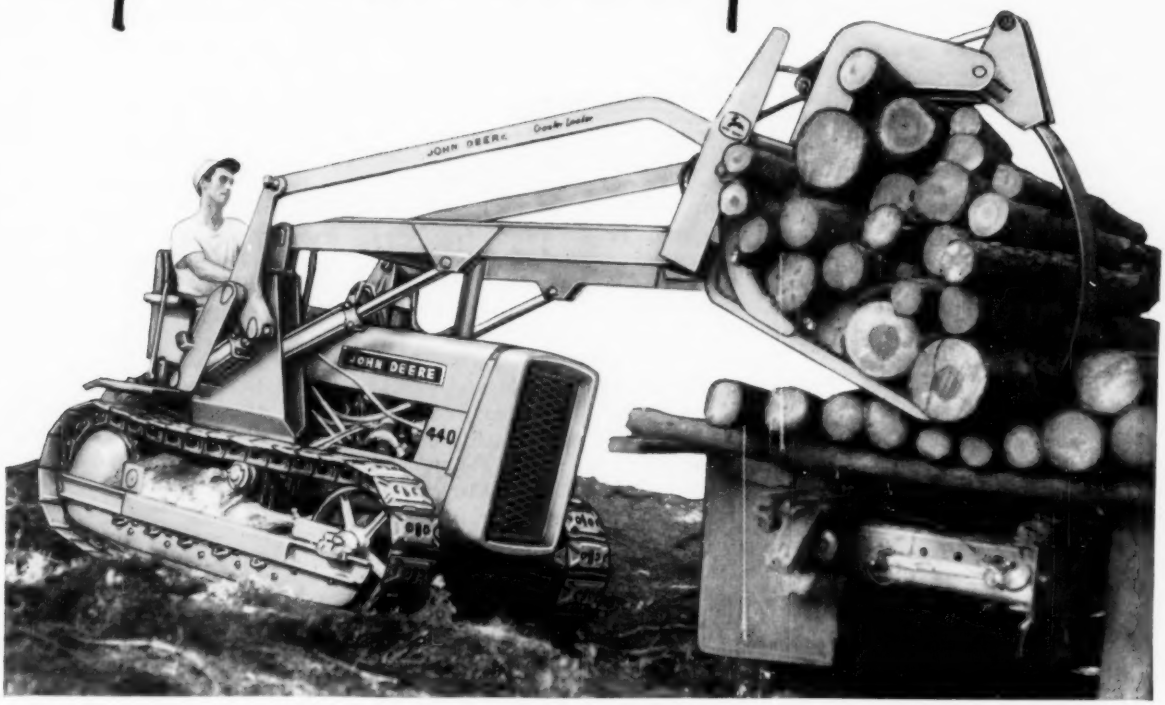

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those who do not specialize? Will they shift to subprofessional or custodial status; can they go into procurement or sales? How will the trend toward increasingly intensive forestry and specialization affect those in education, administration, research, extension, and consultation? How will established foresters be affected? What adjustments can they best make to increase their usefulness as the current development progresses?

These and similar questions deserve attention and widespread discussion if we are to have the kinds of foresters that will be most in demand during the decades ahead. The present situation underscores the need for the Society's impending forest education study, the results of which should help much to shape the future of our profession.

Meanwhile, the straws in the wind indicate that we shall do well to keep closely in touch with the specialists in forestry, even though we may not ourselves wish to specialize.

PHILIP A. BRIEGLEB

Second Call for Council Nominations

All members are hereby notified that the regular biennial election will be held December 5, 1959. A president, vice president, and nine other members of the Council will be elected for the two-year term 1960-1961.

The present Council is listed on page 216. Any or all of these incumbents may be renominated, provided they accept the nomination in writing.

President George A. Garratt has announced that he will not be a candidate for re-election.

Membership on the Council is restricted by the Constitution to Members (formerly Senior Members) and Fellows. Any Member or Fellow is eligible to hold office who is in good standing and who accepts the nomination in writing and declares his willingness to serve if elected.

Each voter will have an opportunity to ballot on all candidates for office. Council members are elected in accordance with the system of proportional representation. The procedure of proportional representation will be explained in a later issue of the JOURNAL. It is the system by which the Society has been electing Council members for more than two decades.

Table 1, page 136 February issue, shows distribution of Council members by states 1944-1959.

Candidates for the office of president are voted on separately; the candidate who receives the highest vote is declared elected president, and the candidate who receives the next highest vote is declared elected vice president. Thus all candidates for president are considered as nominated also for vice president.

How Nominations Are Made

The Constitution (Article VIII, Section 2) states the conditions under which nominations are made by petition.

1. Each petition shall name but one candidate.

2. All candidates must be eligible to hold elective office.

3. A petition shall bear the signatures of at least ten voting members who at the time of signing the petition are eligible to vote in the coming election. (Eligible voting members are Junior Members, Members, and Fellows in good standing.)

4. A voting member may not sign more than one nominating petition for president or more than one nominating petition for a member of the Council. That is, he may sign two, but no more.

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5. Petitions must be in the Society office by September 19, 1959.

The Society has no special form for submitting nominating petitions. They may be written as follows:

We, the undersigned voting members of the Society of American Foresters, hereby nominate John Doe, a Member (or Fellow) for the office of president (or member of the Council) for the two-year term 1960-1961.

No nomination will be considered valid unless supported by the nominee's acceptance in writing.

The form of acceptance of a nomination may read as follows:

"I accept the nomination to the office of President (or to membership on the Council) of the Society of American Foresters for the two-year term 1960-1961, and agree to serve if elected."

All nominating petitions should be sent promptly to the Society office, 425 Mills Building, Washington 6, D. C. The executive secretary will gladly provide information about nominating or election procedure.

According to the Constitution (Article VIII, Section 1) a Nominating Committee has been appointed by President Garratt. The Committee is composed of the following members:

Chairman, Harry Wm. Dengler, Extension Service, University of Maryland, College Park, Md.

Earl J. Adams, 4705 Tenth Avenue South, Minneapolis 7, Minn. (State Division of Forestry.)

Robert R. Milodragovich, U. S. Forest Service, Cody, Wyo.

Harry M. Roller, Jr., Woodlands Department, International Paper Company, Mobile 9, Ala.

George Stenzel, College of Forestry, University of Washington, Seattle 5, Wash.

This committee is charged with the following duties:

1. To set the date of the election. (December 5, 1959, is the date.)

2. To provide for at least two candidates for the office of president, and at least nine candidates for membership on the Council.

3. To receive separate nominating petitions for the office of president and for each member of the Council, and to supplement such petitions when necessary with other nominations in order to comply with item 2 above.

The Nominating Committee will make no nominations of its own unless the voting membership fails to make the required minimum number of nominations by petition. Voting members should accordingly get busy and make their own nominations.

Nominations Received

On the date of going to press the following nominations had been received:

For President

Henry J. Malsberger, Atlanta, Ga. (Vice president 1958-1959.)

For the Council

None.

HARRY WM. DENGLER, *Chairman*
Nominating Committee

Second Call for Fellow Nominations

All Members (formerly Senior Members) and Fellows of the Society are hereby advised that nominations for the grade of Fellow are now open. The

EVERGREEN
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election of Fellows will be held at the time of the Society's regular biennial election, December 5, 1959.

As defined by the Constitution (Article III, Section 7), "Fellows shall be foresters recognized generally throughout the profession as persons who have rendered outstanding service to forestry and to the Society. They shall be elected from the Members."

Nominations by Petition

The procedure for placing Members in nomination for the grade of Fellow is by petition. The Society has no printed form for this purpose; the petition may be typewritten thus:

We, the undersigned Members and Fellows of the Society of American Foresters, hereby nominate John Doe for election to the grade of Fellow in 1959.

Remember these simple rules:

1. A petition may not name more than one candidate.

2. It must be signed by not less than 25 Members or Fellows in good standing.

3. It should be accompanied by a factual, not eulogistic, biographical sketch of at least 300 words giving an account of the nominee's professional career and accomplishments.

4. It must be received in the executive office of the Society in Washington, D. C., not later than September 19,1959.

The executive employees of the Society cannot be responsible for obtaining signatures on partially completed petitions or on petitions incomplete by reason of unacceptable signatures (that is, signatures of other than Members and Fellows in good standing).

Election Procedure

Fellows are not elected by the membership at large, but by a board of electors which consists of all present Fellows, the Council, the chairmen of the 21 Sections, and the chairmen of the 9 subject Divisions.

The system is described in Article IV, Section 4 of the Constitution. To win election a nominee must receive an affirmative vote of not less than one-half the total number of votes cast, as provided in Bylaw 11.

For the 1959 election there will be 129 electors, of whom 89 are Fellows. An elector has one vote only. A Fellow who is also a Council member has but one vote.

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Significance of the Grade

The highest membership distinction that can be conferred by the Society, this grade is awarded in recognition of outstanding service to forestry and to the Society. Fellows do not pay increased dues; their dues are the same as those of Members.

Since the Society was founded in 1900, there have been 125 Fellows elected. At the present time the number of living Fellows is 89.

Since the last election in December 1957, two Fellows have died: S. R. Gevorkiantz of Minnesota and J. S. Holmes of North Carolina.

A list of the current fellows was published in the February issue of the Journal.

Fellow Nominations

On the date of going to press the following Members had been nominated for the grade of Fellow:

Bishop F. Grant, Athens, Ga.

Roster of U. S. Foresters in the International Cooperation Administration, January, 1959[1]

Name	Country	Work description
CLARKE A. ANDERSON	Iraq	Range Management Advisor
MAXWELL E. BECKER	Chile	Forestry Advisor—general
PAUL W. BEDARD	Washington	Assistant Chief, Special Commodities Branch
WALTER L. BENDER	Colombia	Forest Management Advisor
WILLARD E. BOND	Libya	Area Advisor
GEORGE N. BROWN	Turkey	Forestry Advisor—general
ELON H. BOMBERGER	Iran	Forest Survey Advisor—Photogrammetry
LAWRENCE J. CUMMINGS	Colombia	Forestry Advisor—general
GEORGE DOVERSPIKE	Iran	Forestry Advisor—general
LESTER EDGE	Iran	Forest Engineering Advisor
RUDOLPH GUSTAFSON	Iran	Head, Transportation Branch
HARRY HAINES	Nicaragua	Forestry Advisor—general
J. H. HARDEE	Guatemala	Forestry Advisor (Forest School)
TORKEL HOLSOE	Liberia	Forestry Advisor—general
CHARLES JACKSON	Iran	Forest Survey Advisor—Cartography
TIFTCREST KAMPMANN	Iran	Forest Survey Advisor—Mensuration
DAVID N. KEE	Pakistan	Forest Management Advisor
HENRY S. KERNAN	Spain	Forestry Advisor—general
DAYTON P. KIRKHAM	Korea	Forestry Advisor—general
MARVIN KLEMME	Iran	Range Management Advisor
CHARLES KRAEBEL	Taiwan	Forestry Advisor—general
JOSEPH B. MAST	Ethiopia	Range Management Advisor
PAUL B. MAST	Libya	Range Management Advisor
KARL B. MAYER	Afghanistan	Forestry Advisor—general
THOMAS MCKINLEY	Haiti	Forestry Advisor—general
BARRY PARK	Libya	Range Management Advisor
OSCAR PATTON	Jordan	Forestry Advisor—general
KENNETH PEARSE	Guatemala	Deputy Food and Agriculture Officer
EUGENE REICHERT	Bolivia	Deputy Food and Agriculture Officer
EARL J. ROGERS	Iran	Forest Survey Advisor—Project Leader
WALDO SANDS	Cambodia	Forestry Advisor—general
LAWRENCE SHORT	Israel	Range Management Advisor
EARL SMITH	Peru	Forestry Advisor—general
GEORGE SPAUR	Pakistan	Forestry Advisor—general
CARL SVENDBY	Colombia	Forest Extension Advisor
FRED H. VOGEL	Nepal	Forestry Advisor—general
JAMES A. WHITE	Liberia	Forestry Advisor—general
ALVA WILLIAMS	Iran	Forest Survey Advisor—Inventory
PAUL ZEHNGRAFF	Philippines	Forestry Advisor—general

[1]The list does not include short term consultants.

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George Kellogg Slocum (1907-1959)

Professor George K. Slocum of the School of Forestry at North Carolina State College died unexpectedly January 15. He had been associated with the College for 30 years, first as a student and then successively as teaching fellow, instructor, assistant professor, associate professor, and professor.

Professor Slocum was born in Scranton, Pa., November 16, 1907. After graduating from the Staunton Military Academy, he attended the Pennsylvania State Forestry School at Mont Alto for two years before transferring to North Carolina State College. He received the Bachelor of Science degree in forestry in 1931 and the Master of Science degree in 1932.

A distinguished educator, Professor Slocum possessed the rare qualifications requisite to a great teacher. In learning of his death Chancellor C. H. Bostian of North Carolina State College stated that: "North Carolina has lost an outstanding teacher and scientist in the death of Professor Slocum. Few teachers have left such a great impression of respect and endearment in the hearts of their students. Many hundreds of North Carolina State College alumni have had their lives and minds enriched through their association with Professor Slocum."

Professor Slocum was a member of the Society of American Foresters, the American Society of Photogrammetry, the American Forestry Association, and the North Carolina Forestry Association. He was also a member of the honorary scholastic fraternities Phi Kappa Phi, Sigma Xi, and Xi Sigma Pi. He served as advisor to the Forestry Club since its inception. Major contributions to research were in the fields of pine management, silviculture and forest measurements. He is the author of several publications on these and related subjects.

Necrology, 1958

Honorary

Blanford, H. R., England

Fellow

Gevorkiantz, S. R., St. Paul, Minn.
Holmes, J. S., Raleigh, N. C.

Member

Ames, Fred E., Portland, Ore.
Andrews, William B., Jr., Fair Oaks, Calif.
Bowan, E. Ernest, Fort Defiance, Ariz.
Collingwood, G. H., Washington, D. C.

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Flint, Alfred A., Missoula, Mont.
Hansen, Ralph H., Missoula, Mont.
Kemper, Ralph C., Fayetteville, W. Va.
Matson, E. E., Portland, Ore.
Mitchell, William W., Madison, Wis.
Nord, Arthur G., Ogden, Utah
O'Connell, James J., Lewiston, Idaho
O'Roke, E. C., Ann Arbor, Mich.
Pierce, Roy G., Burbank, Calif.
Quick, Walter J., Jr., Bethesda, Md.
Raupach, Carl V., Prineville, Ore.
Shepard, W. C., Berlin, Conn.
Simpson, Lewis L., Medford, Ore.
Taylor, T. G., Milwaukee, Ore.
Walmsley, Cyril E., Shelton, Wash.
Wellberg, Ernest T., Salem, Mo.

Junior

Bentley, Charles F., Lincolnton, Ga.
Carlman, Robert A., Winthrop, Wash.
Eldridge, Theodore, Gainesville, Ga.
Kissinger, Neland A., Jr., Portland, Ore.
Myers, Evamar A., Georgetown, S. C.

Associate

Schnaffner, John V., Jr., Rochester, Vt.
Shoemaker, Henry W., Harrisburg, Pa.

Affiliate

Armstrong, J. J., Savannah, Ga.
Jordan, Carl M., Wells River, Vt.
McLees, John Robert, Sumter, S. C.
Rippe, John D., Zaleski, Ohio
Warner, Eugene V., Long Beach, Calif.

Society Membership Continues to Climb

Society membership, as of December 31, 1958 was 12,188—a net increase over 1957, of 586. Membership, as of December 31, 1957 was 11,602. During 1958, 1,247 new members, including reinstatements, were added. There were 661 terminations of which only 474 were dropped for nonpayment of dues. Total applications processed during 1958 were 2,278, including reinstatements, advancements, and initial grades. Of interest is the continuing increase in the Student and the Member grades.

TABLE 1.—COMPARISON OF INCOME AND EXPENSE 1957-1958

	1957	1958
Income		
Dues	$105,991	$113,716
Fees	1,415	1,131
Subscriptions; sales	10,110	10,008
Advertising	32,055	38,720
Miscellaneous income	5,892	2,807
Forestry Terminology		1,140
Miscellaneous Society publications		920
Forestry Handbook		3,356
Interest; dividends	1,878	2,502
Forest Science (net)	56	1,968
Total	$157,397	$176,268
Expense		
JOURNAL OF FORESTRY	$ 46,548	$ 49,634
Editor's expense	470	986
Salaries, editorial	14,945	17,008
Salary, executive secretary	10,825	11,717
Salaries, office	34,672	36,664
Advertising commission	9,110	10,904
Advertising promotion; expense	4,311	4,474
Travel, officers	4,058	4,202
Postage	2,572	2,454
Telephone; telegram	788	821
Rent	6,689	7,308
Multigraphing; mimeograph	641	387
Miscellaneous printing	1,014	1,274
Office supplies	1,048	1,313
General expense	965	1,358
Depreciation	1,476	1,635
Retirement plan	1,479	1,522
Affiliation dues	160	210
Committee expense	85	93
Division expense	14	22
Grading forestry schools	623	349
Council travel	1,878	942
Social security tax	1,121	1,215
Election of officers; fellows	753	
Equipment maintenance	424	512
Referenda	459	
Proceedings		904
Miscellaneous	527	16
Total	$147,655	$157,924
Net earnings	9,742	18,344

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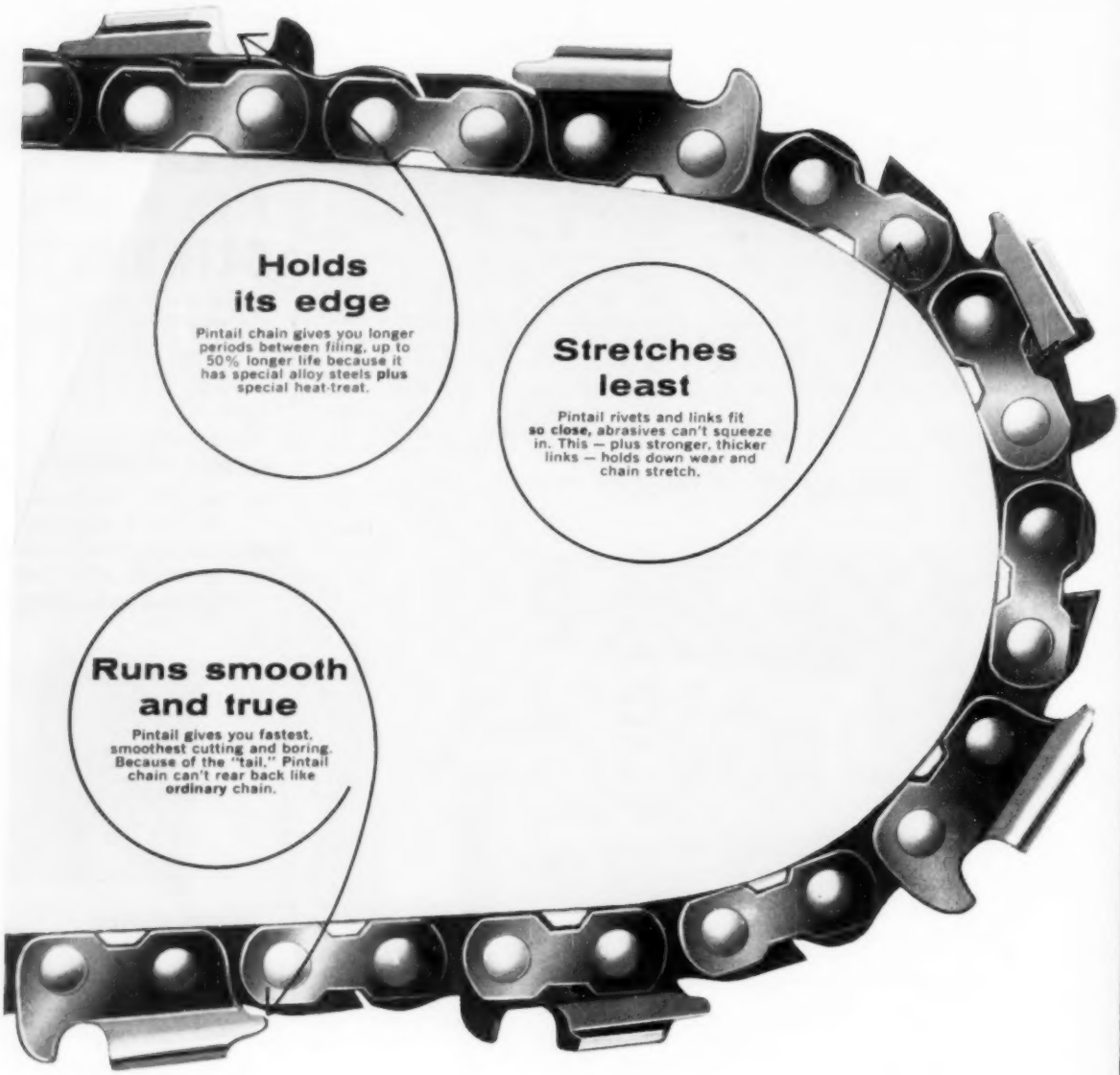
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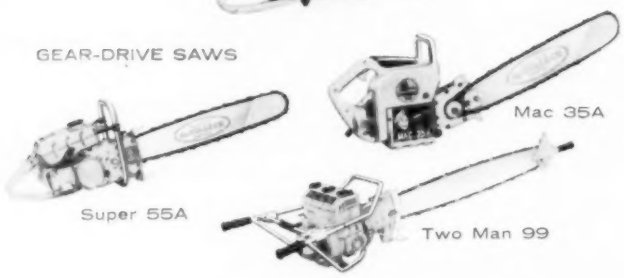

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Comparative membership figures follow:

Grade	1957	1958
Fellow	90	89
Member	5,393	5,710
Junior	3,917	3,955
Student	1,073	1,254
Affiliate	766	797
Associate	239	229
Corresponding	103	134
Honorary	21	20
Total	11,602	12,188

Increased activity, not only in membership but in other Society projects, is reflected in net earnings for 1958 of $18,345—almost double the amount for 1957. (See Table 1.) Society investments (about 94 percent government bonds) purchased at a cost of $21,087 have a market value of $19,168. A total of $52,268 is on deposit in federally insured building and loan associations.

Coming Events

ASP-ASCM Consecutive Meetings

The 25th annual meeting of the American Society of Photogrammetry will be held March 8-11 and the 19th annual meeting of the American Congress on Surveying and Mapping March 11-14 in the Shoreham Hotel, Washington, D. C.

Southern California Section

The spring meeting of the Southern California Section will be held on April 10 and 11, with headquarters in San Diego.

Columbia River Section

The spring meeting of the Columbia River Section will be held on April 18 at Eugene, Ore.

Gulf States Section

Plans have been made for the annual meeting of the Gulf States Section to be held May 7-8, in Tyler, Texas.

Northern California Section

A field meeting of the Northern California Section will be held on June 5 and 6 in the Santa Cruz area.

Lake States Forest Tree Improvement Conference

The Fourth Lake States Forest Tree Improvement Conference has been scheduled for October 6 and 7, at the University of Michigan, Ann Arbor.

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William Chambers Shepard (1883-1958)

William C. Shepard of Berlin, Conn. died suddenly November 27 in Philadelphia, Pa., at the age of 75.

Mr. Shepard was active in Connecticut forestry. From 1948 until 1952 he served as secretary and forester for the Connecticut State Forest and Park Association, and after his retirement from that position he became a director and later vice-president of the association.

Mr. Shepard was born March 29, 1883 in Ogdensburg, N. Y. He received his forestry education at the Cornell Forestry School and Yale, graduating from the latter in 1907. He worked for a time as assistant forester for the Pennsylvania Railroad and then moved to Connecticut where he engaged in dairy farming. Later he became forester at large for the state's CCC program. He also served as acting state forester.

Southwestern Section Holds Historic Meeting

A meeting of the Southwestern Section, attended by 200 members and guests, was held October 24 and 25 at Flagstaff, Ariz.

Jointly sponsored by the Section and the Rocky Mountain Forest and Range Experiment Station, the program was centered around the fiftieth anniversary of the Fort Valley Experimental Forest, the first experimental forest established by the U. S. Forest Service.

With Chairman Arthur T. Upson presiding, the program featured Raymond Price, Station director; Emanuel Fritz, an early forestry employee at Fort Valley; Bert Lexen and George S. Meagher, former research foresters at Fort Valley; and DeWitt Nelson, director of the California Department of Natural Resources.

The following resolution was adopted by acclamation:

Whereas: The Board of Regents of the University and Colleges of Arizona did authorize, and the Arizona State College at Flagstaff, in September 1958 did initiate a Department of Forestry and does now offer a specialized degree in Forestry, and

Whereas: The Southwestern Section, Society of American Foresters, did support the establishment of this Department of Forestry by resolutions passed in regular meetings on May 2, 1958, and April 26, 1957;

Now therefore be it resolved by the Southwestern Section, Society of American Foresters, in regular meeting on October 24, 1958;

1. That the Board of Regents of the University and Colleges of Arizona, and the Arizona State College at Flagstaff, be congratulated on the establishment of this Department of Forestry;

2. That the Arizona State College at Flagstaff be urged to establish and maintain high standards of professional and general instruction in its forestry curriculum, to the end that the curriculum may attain accreditation and that its graduates may compete on an equal footing with the graduates of the older Departments and Schools of Forestry in the United States;

3. That the State College at Flagstaff be urged to establish the degree of Bachelor of Science in Forestry to be awarded to qualified professional graduates; and

4. That copies of this resolution be sent to the President of the Board of Regents and to the President of the Arizona State College at Flagstaff.

An outline of the plans and curriculum for the new Department of Forestry at Arizona State College at Flagstaff was given by President J. Lawrence Walkup and Charles O. Minor, head of the Department.

Henry Clepper, executive secretary, discussed Society Affairs.

At the Section's annual dinner Fred H. Kennedy served as toastmaster. The principal speaker was R. E. McArdle, chief of the Forest Service.

The meeting was concluded with a field trip to Fort Valley under the direction of Edward M. Gaines, research forester in charge of the experimental forest.

Gordon Bade was program chairman for the meeting.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of January are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of April 1959.

Communications from the voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Alison, T. W., Dist. Forester, Buckeye Cellulose Corp., Foley, Fla. (Junior 1952; Member, **Southeastern**).

Allen, K. J., 3122 Plank Rd., Baton Rouge, La. (Student 1957; Junior, **Gulf States**).

Anderson, N. A., Forest Pathologist, Lake States Forest Expt. Station, St. Paul, Minn. (Junior 1952; Member, **Upper Miss. Valley**).

Anderson, R. E., Range Mgr., Bureau of Land Mgmt., Denver, Colo. (Junior 1952; Member, **Washington**).

Asher, J. E., Consulting Forester, Self, Blueiay, Calif. (Junior 1955; Member, **Southern California**).

Backels, J. F., Dendrology Teacher, Paul Smith's College, Paul Smiths, N. Y. (Junior 1952; Member, **Wisconsin-Michigan**).

Baker, J. R., (Student, **LSU**).

Baker, R. H., Forester, Ga. Kraft Co., Perry, Ga. (Junior, **Southeastern**).

Banta, D. G., Forest Eng., Crown Zellerbach Corp., Port Angeles, Wash. (Junior 1952; Member, **Puget Sound**).

Barnard, J. E., (Student, **Pa. State**).

Bartholomew, W. C., Inspector Mgr. Treating Plants, A.T.&S.F. Ry. Co., Topeka, Kan. (Affiliate 1956; Junior, **Ozark**).

Beach, R. E., (Student, **Univ. Ga.**).

Bedell, A. U., (Student, **LSU**).

Beene, J. T., Woodland Cons., Soil Cons. Service, Monticello, Ark. (Rein. Affiliate, **Ozark**).

Beeson, T. M., Forest Consultant, Walterboro, S. C. (Rein. Junior, **Appalachian**).

Belt, M. D., Forester, W. S. Fox & Sons, Pine Bluff, Ark. (Affiliate, **Ozark**).

Bergoffen, G. S., (Student, **State Univ. N. Y.**).

Betts, J. W., Asst. Forest Nurseryman, Ore. Forest Nursery, Bend, Ore. (Junior 1952; Member, **Columbia River**).

Birch, J. E., Unit Forester, Bureau of Land Mgmt., Medford, Ore. (Junior 1952; Member, **Columbia River**).

Bobb, G. N., Asst. Area Forester, Continental Can Co., Inc., Hopewell, Va. (Junior 1955; Member, **Appalachian**).

Boden, W. A., (Student, **Univ. Mich.**).

Bolwell, C. G., Service Forester, R. I. Div. of Forests, Providence, R. I. (Affiliate, **New England**).

Boone, W. L., (Student, **Wash. State**).

Borchers, H. A., (Student, **Iowa State**).

Brady, L. J., Sales Forester, Northern Pacific Railway Co., Seattle, Wash. (Junior 1955; Member, **Puget Sound**).

Brigham, P. M., Forest Nursery Supt., Higgins Lake Nursery, Roscommon, Mich. (Junior, **Wisconsin-Michigan**).

Brookwell, W. T., Forester, Bureau of Land Mgmt., Medford, Ore. (Junior 1954; Member, **Columbia River**).

Burcalow, D. W., Wildlife Proj. Coordinator, Minn. Div. of Game & Fish, St. Paul, Minn. (Rein. Junior, **Upper Miss. Valley**).

Burkhardt, A. F., (Student, **Mich. Mining & Tech**).

Burns, D. M., 2315 Dwight Way, Berkeley, Calif. (Student 1957, Junior, **Northern California**).

Burns, R. V., Dist. Forester, Onyx Dist., Mt. Pine, Ark. (Affiliate, **Ozark**).

Byrd, R. R., P. O. Box 6117, Baton Rouge, La. (Student 1958, Junior, **Gulf States**).

Calder, D. G., Consulting Forest Eng., Eugene, Ore. (Junior 1952; Member, **Columbia River**).

Caldwell, G. H., Unit Forester, International Paper Co., Marion, S. C. (Affiliate, **Appalachian**).

Callahan, T. A., (Student, **LSU**).

Cameron, C. D., (Student, **Univ. Mich.**).

Carver, G. C., Chief Forester, Pope & Talbot Inc., Port Gamble, Wash. (Junior 1955; Member, **Puget Sound**).

Castleman, J. L., (Student, **Univ. Ga.**).

Chalmers, W. K., (Student, **Ore. State**).

Chamberlin, D. C., Forester, USFS, Cave Junction, Ore. (Junior 1952; Member, **Columbia River**).

Cinceci, L. J., (Student, **Mich. Mining & Tech.**).

Clemens, D. L., (Student, **Mich. State**).

Cole, J. F., Timber Consultant, Lowrys, S. C. (Rein. Junior, **Appalachian**).

Colee, E. B., Timber Buyer, Snellstrom Lbr. Co., Eugene, Ore. (Junior 1952; Member, **Columbia River**).

Cooley, M. V., Forest Tech., International Paper Co., Lucedale, Miss. (Affilate, **Gulf States**).

Corbin, R. L., (Student, **Wash. State**).

Covault, J. D., (Student, **Iowa State**).

Craine, J. R., Forester, H. E. Bovay, Consulting Eng., Spokane, Wash. (Junior 1954; Member, **Inland Empire**).

Crawshaw, H. L., Purchaser of Lumber & Logs for Resale, Somerset, Pa. (Junior 1952; Member, **Allegheny**).

Crowe, J. W., (Student, **LSU**).

Daniels, R. H., Utah State Univ., Logan, Utah (Student 1956; Junior, **Intermountain**).

Dark, B. R., Unit Forester, International Paper Co., Bastrop, La. (Junior 1955; Member, **Gulf States**).

Davis, R. A., 2244 E. 92nd, Seattle, Wash. (Student 1958; Junior, **Puget Sound**).

Dell, T. R., (Student, **LSU**).

Dent, A. G., (Student, **Yale**).

Derby, J. E., Great Rd., Stow, Mass. (Student 1956; Junior, **New England**).

Dowling, P. G., Student, LPI, Ruston, La. (Rein. Student, **Gulf States**).

Drinkwater, M. H., Forestry Office, Dept. Northern Affairs & Natl. Resources, Fredericton, N. B., Canada (Affiliate, **New England**).

Duckworth, J. D., Forester, USFS, Bentley, La. (Affiliate, **Gulf States**).

Duda, T. M., 389 East 2nd No., Logan, Utah (Student 1956; Junior, **Intermountain**).

Duncan, J. D., Eng. Dept., Snider Mining Co., Chisholm, Minn. (Junior 1952; Member, **Upper Miss. Valley**).

Dutton, L. A., General Delivery, Jackson, Wyo. (Student 1958; Junior, **Intermountain**).

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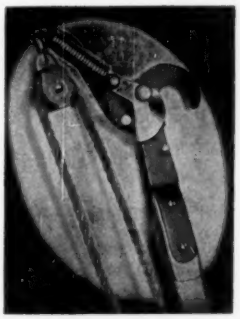

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Ferguson, D. E., (Student, **Univ. Mich.**).
Fish, H. S., Forester, Bureau of Land Mgmt., Sacramento, Calif. (Junior 1952; Member, **Northern California**).
Fisher, J., Forester, USFS, Grangeville, Idaho (Affiliate, **New England**).
Flick, A. B., Forester, N. Y. S. Cons. Dept., Bath, N. Y. (Junior, **New York**).
Ford, R. C., (Student, **Mich. Mining & Tech**).
Francis, G. C., Asst. Dist. Mgr., Bureau of Land Mgmt., Coos Bay, Ore. (Junior, **Columbia River**).
Fredsell, R. M., Forester, Alaska Lumber & Pulp Co. Inc., Sitka, Alaska (Junior, **Puget Sound**).
Freeman, F. W., Horticulturist, Hidden Gardens, Tipton, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Freeman, W. E., P. O. Box 4521, Raleigh, N. C. (Student 1957; Junior, **Appalachian**).

Gall, D. G., 220 Grace Ave., Canonsburg, Pa. (Student 1956; Junior, **Allegheny**).
Garrett, J. M., (Student, **Univ. Ga.**).
Garris, G. R., (Student, **Univ. Ga.**).
Gauthey, L., Forester, USFS, Mammoth Lakes, Calif. (Junior 1952; Member, **Northern California**).
Gibbs, G. A., Area Forest Supt., International Paper Co., Troy, Ala. (Affiliate 1952; Junior, **Southeastern**).
Goldman, J. M., (Student, **LSU**).
Gordon, A. F., (Student, **Univ. Maine**).
Gragg, J. F., (Student, **Mont. State**).
Greig, J. E., Partner, Cal-Pacific Forest Consultants, Sacramento, Calif. (Junior 1952; Member, **Northern California**).
Griffin, J. R., Graduate Student, Univ. Calif., Berkeley, Calif. (Junior 1952; Member, **Northern California**).

Hagenstein, P. R., Working on Doctorate in Forest Economics, Ann Arbor, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Hall, N. L., (Student, **Ore. State**).
Hanna, L. P., USFS, Shelton, Wash. (Affiliate, **Puget Sound**).
Hanna, S. P., Dist. Ranger, Burns Dist.-Malheur Natl. Forest, Burns, Ore. (Junior 1952; Member, **Columbia River**).
Hansen, D. C., (Student, **Univ. Mich.**).
Hanson, D. P., (Student, **Mich. Mining & Tech.**).
Hawes, G. H., (Student, **Univ. Maine**).
Heigh, W. D., Forester, USFS, Idleyld Park, Ore. (Rein. Junior, **Columbia River**).
Heisel, E. A., Forester, Bureau of Indian Affairs, Dixon, Mont. (Junior 1955; Member, **Northern Rocky Mountain**).
Helmly, D. F., (Student, **Univ. Ga.**).
Herring, R. M., Forester, Alaska Lumber & Pulp Co., Sitka, Alaska (Junior, **Puget Sound**).
Heuschkel, D. G., Forester, Steamboat Ranger Station, Idleyld Park, Ore. (Junior 1955; Member, **Columbia River.**).
Hofeldt, V. H., Forester, USFS, Sonora, Calif. (Junior 1952; Member, **Northern California**).
Hohisel, N. S., (Student, **Mich. State**).
Hughes, T. S., Cons. Forester, Texas Farms, Inc., Jasper, Texas (Affiliate, **Gulf States**).
Hunt, J. W., Forester, USFS, Bates, Ore. (Junior 1955; Member, **Columbia River**).

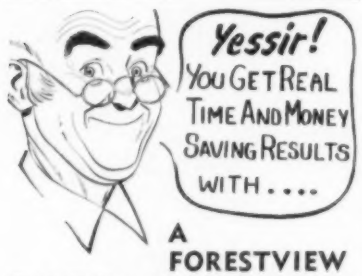
Ibberson, J. E., Chief Div. of Forest Advisory Services, Pa. Dept. of Forests & Waters, Harrisburg, Pa. (Junior 1954; Member, **Allegheny**).

Jacques, G. E., 5 Gilmore St., Waterville, Me., (Student 1957; Junior, **New England**).
Jay, J. W., Staff Asst., Lower Mich. Natl. Forest, Cadillac, Mich. (Rein. Junior, **Wisconsin-Michigan**).
Jenkins, M. E., 189 Silver St., Greenfield, Mass. (Student 1958; Junior, **New England**).
Johnson, F. D., Asst. Prof., College of Forestry, Univ. of Idaho, Moscow, Idaho (Junior 1952; Member, **Inland Empire**).
Johnson, R. B., (Student, **Univ. Minn.**).
Johnstone, C. W., (Student, **Ore. State**).
Jordan, D. H., 1616 E. 50th, Seattle, Wash. (Student 1957; Junior, **Puget Sound**).
Jung, M. W., (Student, **LSU**).
Junk, R. W., Forester, Pierce County Assessors Office, Tacoma, Wash. (Junior 1955; Member, **Puget Sound**).

Keppen, G. H., (Student, **Mich. Mining & Tech.**).
King, R. C., (Student, **Univ. Minn.**).
Klein, E. L., 249 So. Pugh St., State College, Pa. (Student 1957; Junior, **Allegheny**).
Knoerr, K. R., Research Forester, USFS, Soda Springs, Calif. (Junior 1952; Member, **Northern California**).
Konnie, S. F., Forester, Swanson Bros. Logging Co., Noti, Ore. (Junior 1952; Member, **Columbia River**).
Kopitsch, R. L., Student, **Mich. Mining & Tech.**).
Krumm, E. H., 722 Remington, Fort Collins, Colo. (Student 1957; Junior, **Central Rocky Mountain**).

Lankford, R. B., Area Mgr., Union Bag-Camp Paper Corp., Nashville, N. C. (Junior 1955; Member, **Appalachian**).
Lawyer, D. E., State Park Ranger, State Office Bldg., Sacramento, Calif. (Affiliate, **Northern California**).
Lee, H. C., Forest Supv., USFS, Custer, S. Dak. (Rein. Member, **Central Rocky Mountain**).
Lewis, L. L., Asst. Woodlands Mgr., St. Regis Paper Co., Tacoma, Wash. (Junior 1952; Member, **Puget Sound**).
Leys, A. J. (Student, **State Univ. N. Y.**). **N. Y.**).
Litten, G. W., Logging Eng., Crown-Zellerbach Corp., Seaside, Ore. (Junior 1951; Member, **Columbia River**).
Loftus, N., Forester, Rhinelander Paper Co., Rhinelander, Wis. (Junior 1952; Member, **Wisconsin-Michigan**).
Lunday, A. N., Asst. Dist. Forester, Fla. Forest Service, Tallahassee, Fla. (Rein. Junior, **Southeastern**).
Lyon, C. B., Asst. Dist. Ranger, USFS, Butte Meadows, Calif. (Junior 1952; Member, **Northern California**).

Mabe, W. G., Resident Forester, Union Bag-Camp Paper Corp., New Bern,



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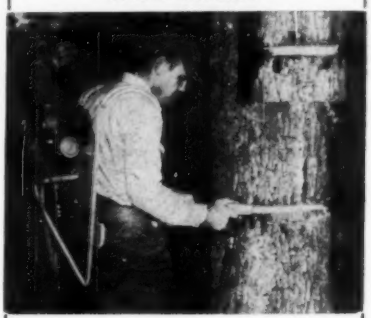

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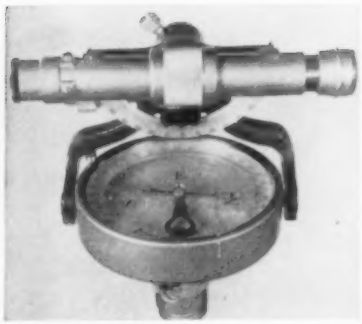

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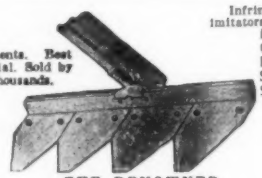
Malloy, E. J., Logging Supt., Medford Corp., Butte Falls, Ore. (Junior 1952; Member, **Columbia River**).
Maloney, R. C., Proj. Eng., USFS, Nevada City, Calif. (Junior 1952; Member, **Northern California**).
Marita, F. J., (Student, **Mich. Mining & Tech.**).
Marsh, L. W., Asst. Ranger, USFS, Camptonville, Calif. (Junior 1952; Member, **Northern California**).
Massie, M., (Student, **Mich. Mining & Tech.**).
Mateer, B. T., (Student, **Univ. Mich.**).
Mattison, J. B., (Student, **LSU**).
May, R. L., Dist. Mgmt. Asst., Va. Div. of Forestry, Abingdon, Va. (Rein. Junior, **Appalachian**).
McClellan, G. E., Assoc. State Forest Ranger, Calif. Div. of Forestry, Spring Valley, Calif. (Junior 1952; Member, **Southern California**).
McElfresh, W. A., Asst. Ext. Forester, VPI, Blacksburg, Va. (Junior 1955; Member, **Appalachian**).
McKenzie, T. A., Leadman, Ga. Pacific Corp., Coos Bay, Ore. (Junior 1955; Member, **Columbia River**).
McKinnon, K. R., Box 632, Ruston, La. (Student 1958; Junior, **Gulf States**).
Mirkes, L. H., Forester, Div. Forests & Parks, Boulder Junction, Wis. (Junior 1952; Member, **Wisconsin-Michigan**).
Mueller, C. S., Forester, Wis. Cons. Dept., Tomahawk, Wis. (Junior 1952; Member, **Wisconsin-Michigan**).

Nicholson, D. C., Tech. Phytochemistry, Forestry Research Center, Centralia, Wash. (Associate, **Puget Sound**).
Nicholson, J. C., Dist. Supt., W. Va. Pulp & Paper Co., Camden, S. C. (Rein. Junior, **Appalachian**).
Nord, J. C., (Student, **Univ. Mich.**).
Nuite, C. W., Forester, Div. of State Parks, Edisto Island, S. C. (Rein. Member, **Appalachian**).

Olson, B. R., (Student, **Univ. Minn.**).
Olson, R. D., 3309 Goldendale Place, Seattle, Wash. (Student 1958; Junior, **Puget Sound**).
Orvis, C. H., 526 Sunset Lane, East Lansing, Mich. (Student 1956; Junior, **Wisconsin-Michigan**).
Oswalt, E. K., Box No. 6, Bonnie Lane, West Lafayette, Ind. (Student 1957; Junior, **Central States**).
Owston, P. W., (Student, **Univ. Mich.**).
Palmer, W. M., (Student, **Pa. State**).
Pasin, S. J., 701 West 2nd St., Cle Elum, Wash. (Student 1956; Junior, **Puget Sound**).
Peterson, C. M., (Student, **Ore. State**).
Peterson, E. B., (Student, **Yale**).
Phillips, J. (Student, **Yale**).
Pierson, G. P., Forester, USFS, Bly, Ore. (Rein. Junior, **Columbia River**).
Pribble, J. L., (Student, **Univ. Mo.**).
Prielipp, D., Forester, Kimberly-Clark, Kingsford, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Prochnau, J. W., Consulting Forester, Albany, Ore. (Junior 1952; Member, **Columbia River**).
Puuri, C. R., (Student, **Mich. Mining & Tech.**).

Raymond, G. E., Asst. Mgr. Forester, Northern Pacific Railway Co., Seattle, Wash. (Junior 1952; Member, **Puget Sound**).
Rea, R. B., (Student, **Univ. Idaho**).
Rhodus, G. I., (Student, **Mich. State**).
Roam, G. A., (Student, **Univ. Minn.**).
Roper, R. M., Box 207, Short Hills, N. J. (Rein. Member, **Allegheny**).
Rosek, W. T., (Student, **Mich. Mining & Tech.**).
Ross, R. E., Branch Mgr., Homelite Corp., Hollidaysburg, Pa. (Junior 1952; Member, **Allegheny**).
Ruby, J. L., Graduate Student, Mich. State, East Lansing, Mich. (Rein. Junior, **Wisconsin-Michigan**).
Rye, J. A., (Student, **Mich. Mining & Tech.**).

Scheer, R. L., Research Forester, Southern Forest Expt. Station, Marianna, Fla. (Rein. Junior, **Southeastern**).
Schemnitz, S.D., Game Biologist, Minn. Div. of Game & Fish, Madelia, Minn. (Junior 1952; Member, **Upper Miss. Valley**).
Schooley, C. M., Dist. Forester, Ishpeming, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Scott, B. D., (Student, **Yale**).
Sendt, W. B., Forester, Silverlake Ranger Dist., Lakeview, Ore. (Junior 1952; Member, **Columbia River**).
Sheldon, K. G., Chief Forester, Rhinelander Paper Co., Rhinelander, Wis. (Junior 1952; Member, **Wisconsin-Michigan**).
Sheppard, J. E., Forest Inventory Asst., Weyerhaeuser Timber Co., Tacoma, Wash. (Junior 1955; Member, **Puget Sound**).
Sherrill, B. C., Consulting Forester, J. F. Siegfried Mining Engineers, Nevada City, Calif. (Junior 1952; Member, **Northern California**).
Shrum, M. D., (Student, **Ore. State**).
Smith, C. L., Forester, Industrial Forestry Assoc., Medford, Ore. (Junior 1952; Member, **Columbia River**).
Smith, G. E., Woodland Cons., Soil Cons. Service, Orangeburg, S. C. (Junior 1955; Member, **Appalachian**).
Smith, V. E., Asst. Dist. Ranger, San Bernardino Natl. Forest, San Bernardino, Calif. (Junior 1952; Member, **Columbia River**).
Snell, R. L., Forester, USFS, Ochoco Natl. Forest, Burns, Ore. (Junior, **Columbia River**).
Spharler, L. E., Forest Tech., Calif. Div. of Forestry, Santa Rosa, Calif. (Junior 1955; Member, **Northern California**).
Spencer, J. D., Forester, International Paper Co., Kosciusko, Miss. (Affiliate, **Gulf States**).



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Stefan, M. E., (Student, **Univ. Minn.**).
Steinhoff, R. J., (Student, **Univ. Idaho**).
Stratton, H. M., Forester, USFS, Alturas, Calif. (Rein. Member, **Northern California**).
Striffler, W. D., Research Forester, Lake States Forest Expt. Station, Wellston, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Stroh, R. C., (Student, **Pa. State**).
Sullivan, R. C., Forester, U. S. Dept. of Agric., Happy Camp, Calif. (Junior 1952; Member, **Northern California**).
Swain, D. H., 3015 N. Meridan St., Indianapolis, Ind. (Student 1957; Junior, **Central States**).

Tabor, H. B., Mgmt. Forester, Miss. Forestry Comm., Grenada, Miss. (Affiliate, **Gulf States**).
Talerico, R. L., Forest Entom., USFS, East Lansing, Mich. (Rein. Junior, **Wisconsin-Michigan**).
Taras, M. A., Forest Products Tech., S.E. Forest Expt. Station, Asheville, N. C. (Junior 1955; Member, **Appalachian**).
Taylor, R. C., Forester, Boise Natl. Forest, Boise, Idaho (Affiliate, **Intermountain**).
Terry, C. T., Unit Forester, International Paper Co., Georgetown, S. C. (Affiliate, **Appalachian**).
Theiler, R. R., (Student, **Mich. Mining & Tech.**).
Thompson, J. L., 2106 East 47th, Seattle, Wash. (Student 1957; Junior, **Puget Sound**).
Tidball, R. R., Graduate Student, Univ. of Calif., Berkeley, Calif. (Junior 1952; Member, **Northern California**).
Tonkin, C. H., Forester, Curtis Co., Marquette, Mich. (Junior 1952; Member, **Wisconsin-Michigan**).
Tory, W. J., (Student, **Mich. State**).
Trayor. R. E., (Student, **Mont. State**).
Trompler, W. P., Farm Forester, Okla. State Div. of Forestry, Chickasha, Okla. (Rein. Affiliate, **Ozark**).

Usher, V. H., Timber Mgmt. Asst., USFS, Nevada City, Calif. (Junior 1952; Member, **Northern California**).

Vail, S. A., Forest Eng., West Tacoma Newsprint Co., Tacoma, Wash. (Junior 1952; Member, **Puget Sound**).
Van Dyke, D. W., (Student, **Ore. State**).
Verucchi, S. J., (Student, **LSU**).
Vogel, M. A., Timber Mgmt. Asst., Colville Natl. Forest, Orient, Wash. (Student 1955; Junior, **Inland Empire**).

Wahl, J. D., Dist. Forester, Weyerhaeuser Timber Co., Kalama, Wash. (Junior 1955; Member, **Columbia River**).
Wahlgren, H. E., Technologist, Forest Products Lab., Madison, Wis. (Junior 1952; Member, **Wisconsin-Michigan**).
Walker, C. M., Publications Office, USFS, Berkley, Calif. (Junior 1952; Member, **Northern California**).
Walker, W. R., Forester, Potlatch Forests, Inc., Headquarters, Idaho (Junior 1952; Member, **Inland Empire**).
Wallace, J. P., Forester, Clatsop Tree Farm, Seaside, Ore. (Junior, **Columbia River**).
Watson, W. J., Route 1, Box 184, Auburn, Ala. (Student 1957; Junior, **Southeastern**).
Weil, J. S., Timber Mgmt. Asst., Bureau of Land Mgmt., Medford. Ore. (Junior 1952; Member, **Columbia River**).
Werner, R. N., Asst. Dist. Ranger, USFS, Miramonte, Calif. (Junior 1952; Member, **Northern California**).
West, A. J., Research Forester, Central Sierra Snow Lab., Soda Springs, Calif. (Junior, **Northern California**).
White, J. A., (Student, **Mich. Mining & Tech.**).
Whitecavage, J. B., (Student, **Pa. State**).
Wilkins, E. C., Dist. Forester, Southland Paper Mills, Crockett, Texas (Junior 1952; Member, **Gulf States**).
Wilson, J. O., Dist. Forest Ranger, Tiller Ranger Station, Tiller, Ore. (Junior 1952; Member, **Columbia River**).
Winkler, D. G., Box 4591, Raleigh, N. C. (Student 1957; Junior, **Appalachian**).
Winters, C. S., (Student, **LSU**).
Wolfer, R. H., (Student, **Mont. State**).
Wollum, A. G., (Student, **Univ. Minn.**).

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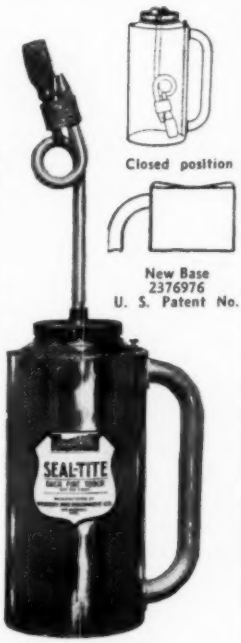

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Forestry News

ROYCE O. CORNELIUS

Named Weyerhaeuser Managing Forester

Royce O. Cornelius has been appointed managing forester of Weyerhaeuser Timber Company, it was announced recently by Edwin F. Heacox, manager of the Timberland Department.

Cornelius has been assistant managing forester in the company's Tacoma headquarters since 1952. He fills the vacancy created by the recent promotion of Heacox.

Cornelius will advise branch foresters on forest management plans for the company's 13 certified tree farms. He will be primarily responsible for maintaining a balanced forest inventory through sustained yield forest management, Heacox stated.

Before joining the Tacoma staff, Cornelius was branch forester at Weyerhaeuser's Coos Bay, Ore., tree farm and branch forester at the Vail-McDonald, Wash., operation.

A graduate of the University of Washington College of Forestry, Cornelius also attended Colorado State College and Biarritz American University in France. He served with the U. S. Army in Europe during World War II.

ARTHUR W. GREELEY

Forest Service Announces Two Top Level Promotions

Arthur W. Greeley, regional forester at Milwaukee, has been named assistant chief of the U. S. Forest Service. He is succeeded by M. M. Nelson, deputy assistant chief in charge of national forest resource management in Washington. The transfers became effective March 1.

In his new position Mr. Greeley succeeds Howard Hopkins, who retired July 1, 1958. As an assistant chief he will help formulate Forest Service policies and act for the Chief

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in matters pertaining to national forest protection and development including forest fire protection, engineering, land classification, and boundary activities.

Mr. Greeley started as assistant ranger on the St. Joe National Forest in Idaho in 1935 and worked up through the ranks as forest ranger, assistant supervisor, forest supervisor, assistant director of a forest and range experiment station, and as regional forester. His assignments took him to Montana, California, the Pacific Northwest, Alaska, and the Lake States region. He received his B.S. degree in forestry from the University of Washington and his Master's degree in forestry from Yale.

Mr. Nelson has been deputy to the assistant chief in charge of the management of natural resources on all the national forests. Prior to that he was assistant regional forester in charge of fire control for the California Region of the Forest Service and served as assistant forest ranger, forest ranger, and forest supervisor in the Pacific Northwest.

Before working for the Forest Service, Mr. Nelson was with the Los Angeles County Forestry Department. He received his B. S. degree in forestry from the University of Washington in 1935.

Bethel Heads Foundation Special Projects

The National Science Foundation has announced the appointment of James S. Bethel as head of the Special Projects in Science Education Section of the Foundation's Division of Scientific Personnel and Education. Bethel is on leave from the School of Forestry, North Carolina State College where he headed up the wood products department. He is a member of the editorial board of the Journal of Forestry.

Appointment to Cabinet Post in Mexico

Dr. Enrique Beltran was in December appointed by the President of Mexico to his Cabinet as Assistant Secretary of Forestry and Game.

Dr. Beltran is an Honorary member of the Society of American Foresters. He prepared Part III, "Forestry and Related Research in Mexico," of the book *Forestry and Related Research in North America* published by the Society in 1955.

SYMBOL OF THE Pennsylvania Forestry Association's Good Outdoor Manners Education Project which began in January is this Good Outdoor Manners Raccoon. After he has been named through a statewide contest open to all Pennsylvania school children, the raccoon will display the association's pleas for general public appreciation of the need for good manners out-of doors, for development of a code of conduct in using forests, fields, and waters as recreation facilities, and for furthering educational programs such as Keep Pennsylvania Green. Arthur C. McIntyre is project director.

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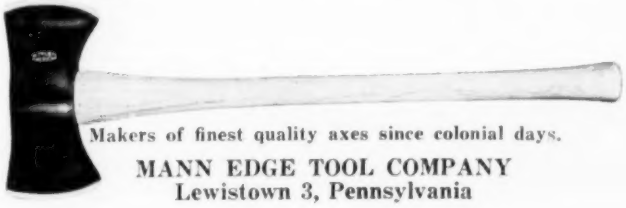

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Heads N.H. Legislative Committee

Robert S. Monahan, a professional forester and member of the New Hampshire House of Representatives, has been named chairman of the House Committee on Resources, Recreation and Development for 1959-60.

Chairmen, Working Committees Named for World Forestry Conference

The organizing committee (see February issue of the JOURNAL) for the Fifth World Forestry Congress to be held at the University of Washington, Seattle, August 29-September 10, 1960, met in January and named the following working committees and chairmen:

Executive, V. L. Harper, U. S. Forest Service; Program, Hardy L. Shirley, State University of New York; Finance, Corydon Wagner, St. Paul and Tacoma Lumber Co.; Tours, Henry Clepper, Society of American Foresters; Machinery and Equipment Exhibits, E. P. Stamm, Crown Zellerbach Corp.; Educational Exhibits, Henry Schmitz, University of Washington; Information and Publicity, Clint Davis, U. S. Forest Service; Local Arrangements, Gordon Marckworth, University of Washington.

At the organizing committee's two-day meeting it also made plans to set up programs and accommodations for the foresters and related scientists who will be invited to the Congress from about 80 nations.

Horacio Recart President Chilean Forestry Association

Horacio Recart, a Corresponding Member of the Society of American Foresters, was recently elected president of the Association of Forest Engineers of Chile.

A native of Santiago, Chile, Sr. Recart is a forestry graduate of the University of Washington.

Florida Forestry Council Meets

The Florida Forestry Council held its annual meeting at Chipola Junior College, Marianna, Fla., December 5th, 1958.

The council plans to undertake a study of forest taxation, which it hopes to publish in brochure form.

Julius Stern, president of Southern Plywoods, Inc. of Greenville, Fla., was elected chairman of the council, Thomas G. Herndon, extension forester, was elected vice-chairman, and Prof. Charles G. Geltz, School of Forestry, University of Florida, was retained as secretary-treasurer.

The next meeting of the council will be held in May to review the work of the various committees dealing with various phases of taxation, and legislation on taxation of other states.

Appointed FAO Assistant Director-General

B. R. Sen, director-general of the FAO, has announced the appointment of Frank Wilson Parker of Hamilton, Ill., as assistant director-general in charge of FAO's Technical Department.

Dr. Parker assumes his new duties in March, leaving a position as chief agriculturalist of the ICA Mission to India.

Prior to his ICA post, Dr. Parker served as head soil scientist and assistant chief of the USDA's Bureau of Plant Industry and director of soils research.

Theme of 1959 National Wildlife Week Announced

"Conservation in the Schools" is the theme of the 1959 National Wildlife Week, March 15-21, sponsored by the National Wildlife Federation and its state affiliates. First proclaimed by President Roosevelt in 1938, the week is each year devoted to emphasis on a chosen subject in order to focus public attention on the importance of natural resources and the problems of conservation. The campaign this year will stress "the need for a conservation curriculum in our schools to educate our younger generations in the importance of the wise use of our natural resources." It is carried on throughout the year by the Federation and cooperating organizations. Interested organizations and individuals may secure "Conservation in the Schools" publicity material from the National Wildlife Federation, 232 Carroll St., N.W., Washington 12, D. C.

Southern Forestry Conference Scheduled

The Forest Farmers Association will hold its 1959 Southern Forestry Conference April 23-24 at Tuscaloosa, Ala. The program will be built around the theme "Expanding Forest Development through Research."

A special scheduled feature of the conference will be a program honoring Walter J. Damtoft, pioneer southern industrial forester, at a luncheon on April 23.

Conference headquarters are the Hotel Stafford.

Private & Industrial

Nickey Bros. Promotions Announced

Russell Stadelman, chief forester since 1946 for Nickey Bros., Inc., Memphis, Tenn., has been named vice president of the company in charge of procurement.

The post of chief forester has been filled by the promotion of W. Z. Hawkins.

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Continental Can Establishes New Woodlands Division

Continental Can Co. has established a Woodlands Division in its Robert Gair Paper Products Group to manage its more than a million acres of timberlands in seven southern states, Charles B. Stauffacher, group executive vice president, announced.

General manager of the new division is T. W. Earle of Savannah, Ga., who previously headed Continental's wood

T. W. EARLE

land operations in its Containerboard and Kraft Paper Division.

Walter J. Damtoft Retires from Champion

Walter J. Damtoft of Asheville, N. C. has retired as secretary and director of the general woods department of Champion Paper and Fibre Company.

Mr. Damtoft first joined the company in 1920 as chief forester. He began his forestry career in 1911 with the U. S. Forest Service and served on the Pisgah National Forest in North Carolina.

A graduate of Yale, he has served as president of the Southern Pulpwood Conservation Association, and vice president of AFPI. He was a member of the Council of SAF for two terms, 1944-1947.

Southern Pulpwood Conservation Association Marks Anniversary

Observing its twentieth anniversary, the Southern Pulpwood Conservation Association held its annual meeting in Atlanta, Ga., January 14-15, with an attendance of more than 400 members and guests.

At the conservation foresters' open meeting, better methods of communicating forestry knowledge to the public were discussed under the leadership of Dr. Richard L. Henderson of Emory University. At this session John Witherspoon, assistant general manager of SPCA, outlined the association's program for setting up "pilot forests," demonstration areas to help small woodland owners improve their management practices. Frank Heyward of Gaylord Container Corporation, Division of Crown Zellerbach Corporation, discussed the public relations aspects of the industrial forester's job.

Among the speakers at other sessions were Dr. Lincoln R. Thiesmeyer of the Pulp and Paper Research Institute of

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Canada; J. W. Warner, president of Gulf States Paper Corporation; and Dr. H. R. Josephson, chief of Forest Economics Research for the U. S. Forest Service, who discussed new population trends and wood use.

Karl A. Swenning of Scott Paper Company was elected SPCA president, succeeding L. A. Whittle of Brunswick Pulp and Paper Company.

Hodges Named to NLMA Post

Ralph Hodges has been appointed director of the Forestry and Economics Division of the National Lumber Manufacturers Association, Washington, D. C.

He succeeds A. Z. Nelson, who has been named director of NLMA's Industry-Government Affairs Division.

From 1946 to 1950, Hodges held positions with Rayonier, Inc., Sapho, Wash.; the forest engineering firm of Porteous and Co., Seattle, and the Harbor Plywood Corp., Lewis River, Wash.

He served as California district forest engineer for the Western Pine Association, Portland, Ore., from 1950 to 1955 and since then has been employed as forester for the Wetsel-Oviatt Lumber Co. with operations in central and southern California.

Hodges is a veteran of World War II, and a forestry graduate of the University of California.

Record Number of Tree Farms Added in 1958

The industry-sponsored Tree Farm movement added 2,998 new tree farms in 1958 to establish a new record of growth for the 18-year-old American Tree Farm System.

The new tree farms, said James C. McClellan, chief forester for American Forest Products Industries, gave the program a boost of 3,481,534 acres, bringing the year-end totals to 13,935 certified tree farms covering 48,429,451 acres.

This compares with 10,937 certified tree farms and 44,947,917 acres on the rolls a year ago.

Four states—three of them in the South—have passed the 4 million-acre mark in tree farms. Florida leads with 4,665,009 acres; Georgia is second with 4,533,680 acres; Alabama third with 4,366,410 acres, and Oregon fourth with 4,031,301 acres. Mississippi continues to lead in the number of certified Tree Farms with 1,455. Alabama is second with 1,210; Texas third with 1,182.

McClellan said another outstanding

industry forestry project of 1958 was the national 4-H Forestry Contest in which more than 70,000 boys and girls in 48 states competed for prizes given by forest industries.

Honored for Wood Promotion Work

N. Floyd McGowin, president of the W. T. Smith Lumber Co., Chapman, Ala., and board chairman of the National Lumber Manufacturers Association, Washington, has been chosen "Lumberman of the Year" by *Crow's Lumber Digest,* a leading lumber trade publication.

McGowin was cited as the man most responsible for convincing lumber manufacturers of the need to launch a new, million-dollar National Wood Promotion Program aimed at boosting sales of lumber and wood products in building and other markets.

As president of NLMA during 1958, McGowin personally stumped the country, urging approval of the program by regional lumber trade associations.

Public

Defense Department Conservation Committee Established

As a result of Public Law 337 which requires Congressional approval for military land withdrawals of more than 5,000 acres the Department of Defense has issued a conservation policy to all military departments and established a special Conservation Committee.

The directive states: "All military installations or facilities which contain suitable land and water areas as determined after consultation with authorized State or Federal conservation authorities shall have an active, progressive program for the management of renewable natural resources. Such programs will incorporate proper techniques and be designed to promote the conservation, through wise use, of the soil, water, forests, grasslands, fish and wildlife and will include assistance and participation in research projects conducted by Federal, Territorial, State and local conservation agencies."

Leslie V. Dix, chief of the Defense-State Relations Branch in the Office of the Assistant Secretary of Defense, is chairman of the special committee. Other members are: Marine Col. C. O. Totman, a professional forester representing the Navy; E. A. Seaman, a biologist representing the Air Force; and Major Pavick, a career Army man.

Retirement of E. D. Sandvig Announced

The retirement of Earl D. Sandvig, chief of personnel management in the regional office of the U. S. Forest Service at Portland and his replacement by Dan E. Bulfer were announced in January by Regional Forester, J. Herbert Stone. Mr. Sandvig had been in his assistant regional forester position since 1954 when he returned to the Forest Service from a two-year assignment to Chile for the Foreign Agricultural Organization. Mr. Bulfer has been in the Personnel Management Division at the Washington, D. C. headquarters for the past two years.

Following his retirement Mr. Sandvig has joined the Territorial Forestry Organization in Hawaii as deputy territorial forester.

Before his commission to Chile, Sandvig was chief of range and wildlife management of the Pacific Northwest Region. A native of Minnesota he graduated from Montana State University in 1923. He has served as supervisor of the Beaverhead National Forest, Montana, and as chief of range and wildlife management of both the Northern Region and the Rocky Mountain Region.

Bulfer graduated from the University of Minnesota in 1930 with a B. S. in forestry. He was a forest supervisor of the Nicolet and Chippewa National Forests in Wisconsin and Minnesota respectively just before his transfer to Washington, D. C. in 1956. He served four years with the Army Air Corps during World War II, much of it in China.

Kelley Will Head Alabama Conservation Department

Claude D. Kelley, of Atmore, Ala., became director of the Alabama Department of Conservation on Jan. 19. The Alabama Department of Conservation consists of the divisions of Game and Fish, Forestry, Parks, State

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Lands, and Sea Foods.

Executive officer of an Atmore oil company, Kelley has served as the nonsalaried president of the National Wildlife Federation for nine consecutive years. He also serves as chairman of the Board of Directors of the Federation.

Kelley's career in conservation work began in 1940 when he was elected president of the Monroe County (Alabama) Wildlife Federation. He filled numerous offices and posts of responsibility, including the presidency of the Alabama Wildlife Federation in later years. He became president of the National Wildlife Federation in 1950, two years after being elected a regional director.

Ilch Heads New Rocky Mountain Division

Director Raymond Price of the Rocky Mountain Forest and Range Experiment Station, U. S. Forest Service, has announced the establishment of a new division of station management to advise the director and his seven technical divisions on coordination of research programs, administrative management of those programs, and dissemination of research results.

David M. Ilch has been transferred from the Washington Office of the Forest Service to serve as chief of this new division. Mr. Ilch entered the Forest Service in 1931 following graduation in forestry from Iowa State College. His first regular assignment was at the California Forest and Range Experiment Station.

During World War II Ilch served with the Navy in the Pacific area.

On his return in 1946 he became chief of the Division of Flood Control Surveys at the California Station. In 1952 he transferred to the Washington Office of the Forest Service where he held positions in watershed research, river-basin planning, and flood-prevention activities and during the past two years carried on special audit work of the regional offices and experiment stations.

Progress Report on Mission 66 Issued by Interior

Secretary of the Interior Fred A. Seaton reported in January that 417 projects valued at $25,406,539 under the National Park Service's MISSION 66 have been completed since July 1, 1958, and that 660 projects totalling $51,765,144 were under construction by the end of 1958.

The National Park Service's 10-year program of park development and conservation is designed to provide adequate park facilities for an anticipated 80 million visitors by 1966.

A total of 1,151 projects valued at $82,632,508 have been programmed by the Department since the start of MISSION 66 in the latter half of 1956. Anticipated construction will total $99,847,179.

The Secretary pointed out that private industry has invested more than $18 million in new and improved visitor accommodations since the start of MISSION 66. For example, concessionaires have spent $5,500,000 in Yellowstone National Park; $1,250,000 in Yosemite National Park; $1,000,000 in Everglades National Park; $600,000 in Mount Rushmore National Monument; and $500,000 in Grand Canyon National Park.

By 1966, it is expected that private industry will have constructed new overnight facilities for 20,000 visitors, as well as necessary eating establishments, service stations, grocery stores, trailer villages, and other visitor accommodations.

Small Ownership Conferences Draw Good Attendance

Some 5,000 people attended the nationwide series of "Small Ownership" meetings held during the latter part of 1958, according to a recent release by the Department of Agriculture. Called by the U. S. Forest Service in cooperation with state foresters, the purpose of the meetings was to discuss ways of improving the condition of the country's 4.5 million farm and other small forest properties that comprise over half the nation's commercial forest land.

Of the people attending the discussion meetings it is reported that 40 percent were small woodland owners. The others were representatives of forest industries, bankers, insurance men, lawyers, state and federal officials, and persons with a general interest in the subject.

The regional offices of the Forest Service are in process of analyzing the transcripts of the meetings, after which it is expected that a Washington office task force will do so on a national basis from which will evolve Forest Service recommendations.

Education

Second Annual Conclave of Southern Forestry Schools

The students of the Louisiana State University School of Forestry, Baton Rouge, have begun plans for sponsoring the Second Annual Conclave of Southern Forestry Schools. This southwide field day is to be held at Camp Grant Walker near Alexandria, La. on May 2.

Last spring, over 150 forestry students, from seven schools, participated in the First Conclave initiated and sponsored by the University of Georgia School of Forestry. Forest industries throughout Georgia supported the conclave.

This year, L.S.U.'s School of Forestry, with the aid of Louisiana's forest industries, is host.

University of Michigan Foresters Visit Puerto Rico

A group of forestry students from the University of Michigan made a forestry study tour in Puerto Rico December 27 to January 2, 1959. The trip was conducted by Professor Kenneth P. Davis and was handled in conjunction with a tour group from the University International Center covering the same dates.

Graduate forestry students making the trip were: Kenneth C. Chilman, Robert E. Farmer, and William J. Potter, U.S.A. Michigan students from abroad were Pit Hambanonda from Thailand; Solomon Quaynor, Kweku O. A. Mensah and Albert K. Tufour from Ghana.

The forestry itinerary in Puerto Rico was arranged and conducted by Dr. Frank H. Wadsworth (Ph.D. Michigan 1950) leader, Tropical Forest Research Center, U. S. Forest Service, assisted by Ralph Throop and Joseph Sposta of his staff.

The tour included a good cross section of tropical forest research and management in an area where population pressure on a sharply limited agricultural land base is extremely high.

Sullivan on Duke Faculty

John D. Sullivan has joined the staff of the Duke University School of Forestry as assistant professor of wood technology. The appointment became effective January 1.

Dr. Sullivan, formerly on the faculty of Michigan State University, East Lansing, will teach courses in timber physics and chemistry of wood.

Forestry Department Established at Arizona State

A Department of Forestry was established at Arizona State College, Flagstaff, in September, 1958 with an enrollment of some 60 students. Dr. Charles O. Minor was appointed head of the new department. He has recently announced the appointment of Martin B. Applequist to the staff.

Dr. Minor received the B.S. degree in forestry from Iowa State College in 1941, the M.F. degree from Duke University in 1942, and a Ph.D. from Duke in 1958. His experience includes teaching at Louisiana State and Clemson College, and work as administrative forester with Kirby Lumber Co., Houston, Texas.

Prof. Applequist will handle the fields of soils and silviculture. He is a 1940 forestry graduate of Iowa State with an M.F. from Duke in 1941. He has completed requirements for the doctorate at the latter institution as recipient of the Brunswick Pulp and Paper Co. scholarship. For the past 12 years he has taught at Louisiana State.

According to Dr. Minor, facilities for instruction in forestry at Flagstaff "include the oldest experimental forest in the United States at Fort Valley, sawmills, pulp mill, and the largest ponderosa pine forest in America."

Southern Educators Meet

The Division of Forestry Education of the Southern Regional Education Board met at the University of Florida in December. The program dealt with the recruitment of outstanding students for forestry, a study of desirable curricula changes, and the role of forest research as related to graduate programs. In attendance were Dr. William Godwin and Lloyd Chapin of the Southern Regional Board, E. L. Demmon, forestry consultant to the board,

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and the following deans and directors of forestry schools and departments: E. S. Harrar, Duke University; R. J. Preston, North Carolina State; A. M. Herrick, University of Georgia; C. M. Kaufman, University of Florida; Paul Y. Burns, Louisiana State; Wilbur DeVall, Alabama Polytechnic Institute; and Lloyd Blackwell, Louisiana Polytechnic Institute.

Stamm to Join North Carolina Faculty

In July Alfred J. Stamm will join the faculty of the School of Forestry at North Carolina State College, Raleigh, as research associate professor of wood technology.

At the present time Mr. Stamm is chemist and subject matter specialist with the Forest Products Laboratory, Madison, Wis.

M.S.U. Kiln Drying Short Course

Norman C. Higgins, extension specialist in forest products at Michigan State University announces that M.S.U. will act as host for the 1959 Short Course in Kiln Drying, March 16-20. It will be cooperatively conducted by the following agencies: Delmhorst Instrument Company, Foxbora Company, Iowa State College, Michigan State University, Moore Dry Kiln Company, Purdue University, Southern Illinois University, Standard Dry Kiln Company, University of Illinois, University of Michigan, Wel-Dri Company.

This 5-day course will place emphasis on practical aspects of seasoning. It is designed to be of value to experienced operators as well as beginning operators, to yard superintendents, management personnel, or any others interested in obtaining the latest information about the seasoning of wood, through instruction, demonstration, and discussion.

The registration fee of $35.00 will include instruction, a large number of publications on the general subject of wood seasoning, a group banquet, and a course certificate.

For further information and registration blanks and room reservations, write to: Cooperative Kiln Drying Course, Kellogg Center, Continuing Education Service, Michigan State University, East Lansing, Michigan.

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Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

Position Available

Vacancy for assistant professor of forestry starting September 1st at Humboldt State College, Arcata, Calif. Should have completed, or near completion, work for doctor's degree, with teaching experience. Under age 45 preferred. Starting salary $6060-$6360 for nine months academic year. To teach general forestry courses including mensuration and protection (fire); 12 lecture hours weekly. Send application by letter with recent photograph to Dr. Homer P. Balabanis, Dean of Instruction, Humboldt State College, Arcata, Calif.

Positions Wanted

Employment wanted with large lumber company, pulp and paper company, or university in the field of research, public relations, or teaching by graduate of Upper Canada College, Toronto, (1948); Univ. of Toronto, B.Sc.F. (1957); Univ. of Calif., M.S., (1958). Three years' experience as reporter-photographer on a large Canadian newspaper. Summer employment in various fields of forestry. One year of research for Master's thesis in Soils and Ecology.

Replies to John B. McDonald, University of California, School of Forestry, Berkeley, Calif.

Experienced professional forester, registered engineer, B.S. Oregon State. Over 12 years experience in private industry. Thoroughly qualified in timber and land management, logging, road construction, cruising, timber appraisals, surveying, and operational planning and administration. Desire permanent position. Willing to relocate.

Box A, Journal of Forestry, Mills Building, Washington 6, D. C.

Experienced tree farm manager desires to relocate. B.S. (Forestry) age 34, married, two children. Presently employed as an assistant forester, but desires a position with more responsibilities and opportunity. Detailed summary of experience and qualifications furnished upon request.

Box B, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S., Major Logging Engineer 1951. Veteran, age 35, married, one child. Experience: 6 years Industry, 15 months State Forestry, all types field engineering and office engineering. College included photogrammetry. Prefer the West, upper Midwest, or Alaska. Desire position with opportunity for advancement.

Box C, Journal of Forestry, Mills Building, Washington 6, D. C.

Wanted Overseas Position—or Southwest or West Coast U. S., in forest management public agency or private industry. Forest Mgt. North Carolina State 1958, M.S. State University College of Forestry at Syracuse University June 1959. Age 26, married, military obligation completed. Three years experience surveying. Also, summer and part-time employment in forestry.

Box D, Journal of Forestry, Mills Building, Washington 6, D. C.

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